APPENDIX A: Model Data Questionnaire Responses

VIC ALPHA (DISMOUTED SOLDIER SIMULATION) MODELS

HUMAN MODELS

1. Vision

The field of view of the soldier is 45 degrees horizontal on a head-mounted display with resolution of 420hx230v pixels. Environmental effects include fog and time of day, which are adjustable by the user. Range is limited by the resolution of the head mounted display. A human-sized target disappears at a distance of a couple hundred meters.

2. Hearing

Hearing is modeled using the Soundstorm 3D system. Soundstorm produces 3-dimensional spatial sound from an earpoint fixed to the position and orientation of the soldier. Battlefield effects are heard (fire, collision, detonation), as are sounds from moving models, such as tanks.

3. Other Senses Modeled

No other senses are modeled

4. Movement/Locomotion

VIC Alpha supports walking, running, and crawling movements. Movement correlates directly with the movement of the subject within the motion capture area. When distances greater than the motion capture area are to be covered, the soldier can walk and run by 4 different means. The type most commonly supported is by going into the "forced movement circle" within the motion capture area and pointing the waist in the direction of desired movement. Speed slowly picks up through walking and running paces. Shortly, a wireless joystick implementation will be in place to allow the soldier to control the speed and direction of movement through a joystick. Speed is limited to 3.6 meters per second. Speed is not affected by terrain slope or soil type. Streams and water can currently be forded. In fact, since the terrain doesn't affect locomotion, even lakes and oceans can be forded. Rolling is also supported by the DSS system, as is the ability to climb stairs and jump out of windows. The soldier is able to look in any direction, independent of the way that he is moving. Collision detection is based on a bounding diamond around the model's waist. The volume is constant and doesn't depend on posture or extending limbs.

5. Postures

The currently supported postures include standing, walking, running, kneeling, jumping, prone, crawling, and rolling.

6. Gestures

Gestures currently are generated, but not recognized. Supported gestures include both stationary and moving gestures. Stationary gestures include disregard, line formation, wedge formation, halt, do not understand, and nuclear warning. Moving gestures include air attack, NBC hazard, attention, increase speed, decrease speed, out of action, cease firing, commence firing, assembly, fix bayonets, column formation, and prepare for action.

7. Hit damage assessment

The algorithm for damage assessment involves a user-selectable probability algorithm. First, a determination is made as to which quadrant the DI has been hit in, i.e. left arm, left leg, right arm, right leg, or torso. If the DI is hit in any of the appendages, that appendage will no longer be animated. If both legs are hit, the DI can no longer walk. If either arm is hit, the DI drops the weapon. If the DI is hit in the torso, the DI drops to the ground and is dead. The user selects the probability that the hit was on the torso from 0 percent chance to 100 percent chance. The probability of hit in the remaining appendages is divided equally amongst the remaining percentage.

SENSOR MODELS

1. Types Supported

VIC Alpha supports night vision and a flashlight.

2. Dynamic Field of View Adjustment

The operator can set the field of view from 45 degrees to 180 degrees. The optical image is severely distorted by high field of views, however.

3. Resolution Adjustment

There is no way to adjust the resolution dynamically.

4. Impact on target acquisition models

Not applicable.

5. Combat identification simulation

Not applicable

WEAPON MODELS

1. Weapon types supported

M16 and AT4 are both supported physically and through graphics models. Any other weapon (such as SAW) is modeled through enumeration changes through DIS.

2. Ballistic Models: Effective ranges

Ballistic models for both the M16 and AT4 use straight line-of-sight vector intersection to a range of 500 meters.

3. Munitions types and effects

Any munitions type can be modeled through DIS enumerations.

4. Sensors associated with weapons for sighting/aiming (scopes, IR aiming dots, etc.)

The M16 has a virtual scope. A sight picture of the target is obtained by lining up the tick at the end of the weapon within the circle near the handle in the direction of the target. A simulated IHAS is also supported which displays the image of a camera mounted at the end of the weapon in the upper right hand portion of the user’s visual scene.

DISPLAY

1. Differential display of entities based on detection/recognition status

The VIC Alpha system supports different levels of detail. However, the display is not based upon detection/recognition status, but rather upon distance.

2. Level of detail for models, range filters, dynamic LOD, e.g., for animation of DI models

The VIC Alpha system supports different levels of detail for models depending on their distance from the eyepoint. Range filters are also applied to the models and is user-selectable. Near and far clipping planes can be dynamically changed to affect the scene picture.

Reality By Design Model Information

Human (Dismounted Infantry) Models

Vision

Detection/acquisition model - Field of view, range effects, environmental effects

Simulator can model fog/haze and damaged/destroyed vehicles smoking.

Near and Far clipping planes are user definable.

Delta: FOV depends on distance from screen, both horizontal and vertical FOV change dynamically and image may have horizontal and vertical skewing based on soldier position and posture in the operational area.

Echo: Presumably same as Delta with default FOV for each of the three channels being 50x50 degrees.

Golf: Planned 50x50deg FOV per eye. Stereo and non-stereo modes.

Hearing

Modeled for SAF? If so, parameters of model. **N/A**

Presentation to user: directional (stereo) or spatial (3-D) **Directional is SVS default sound is used; spatial if SoundStorm3D is used.**

Other senses modeled? **NO**

Movement/locomotion:

Walking, running, crawling

Default speeds

In meters per second:

MAX_SPEED_JOG	**3.80**	
MAX_SPEED_WALK	**1.65f**	
MAX_SPEED_WALK_BACK	**0.45**	**// negative**
MAX_SPEED_WALK_LO	**0.50**	
MAX_SPEED_WALK_LO_BACK	**0.61**	**// negative**
MAX_SPEED_CRAWL	**0.38**	

Side-stepping is allowed from the tabletop joystick and the speeds for side-steeping are 1/2 the above speeds based on posture. Currently, these values are hard-coded. If time permits, we plan to modify SVS to define these speeds from a data file.

Speeds effected by terrain slope, soil type, etc.? **No**

Ford streams and other shallow water terrain? **Yes**

Other behaviors such as rolling, climbing that support surmounting obstacles? **No**

Able to look in a direction different than the one moving in (while moving)? **No with Delta and Echo (other than based on wide FOVs), Yes with Golf**

Collision testing: bounding volumes, variable depending on posture or extending limbs, e.g., arms? **No, vector based on movement/velocity, currently not dependent on posture.**

Postures: Standing, kneeling, prone, crouching, . . . **Standing/Walking/Running, kneeling, prone, crawling (speed while prone), crouching (speed while kneeling)**

Gestures: List gestures supported (generation VICs and SAF, recognition SAF) **None**

VIC generation: continuous user movement tracking or canned motion? **Canned animations triggered by speed and posture/appearance bits.**

Hit damage assessment: wound/kill models or algorithms **One direct hit one kill. Blast damage possible based on munition type and range to detonation.**

Sensor Models

Types supported:

Passive: NVG (I^2), IR, optical **Basic NVG, optical video camera on weapon**

Active: Laser, IR aiming dot, lights **Lasing when used with LWS**

Dynamic field of view adjustment? **Yes for Bravo, Probably for Echo, No for Golf**

Resolution adjustments? **Not currently**

Impact on target acquisition models? **Only difference is visual**

Combat identification simulation? **Not currently**

Weapon Models

Weapon types supported **M16, M203, AK47, LW rifle for our local entity**

Ballistic model(s): effective ranges **Laser (line-of-sight, no gravity, etc.) and Physically based Bullets, Rockets and Guided missiles with full physics modeled.**

Munitions types and effects **All standard munition types supported. Fire and detonate effects based on munition type.**

Sensors associated with weapons for sighting/aiming (scopes, IR aiming dots, etc.) **Rifle Video View displayed in IHAS. Able to use surrogate weapon iron sites for aiming.**

<u>Display</u>

Differential display of entities based on detection/recognition status? **Entity appearance based on PDU data, can use Placards -- will use DI-GUY text strings when implemented.**

Level of detail for models; range filters; dynamic LOD, e.g., for animation of DI models. **LOD on DI based on distance.**

DI SAF

1. Vision
FOV: We are planning to give them 60 degrees horizontal, and 60 degrees vertical. Note that we will also allow the eyes to pan +- 20 degrees without moving the body at all (eye movement), and they will be part of an upper body which we will allow to rotate +-30 degrees. These rotations will not be reported on DIS. Thus while the SAF IC can only see 60 degrees at a time, it can possibly view objects +-80 degrees from the direction the body (i.e., the feet) are facing. We want to model a head too, but probably will skip it due to lack of time. The eye height is 1.7m.

The acquisition model, with effects of range, environment, etc., is described somewhat in the ModSAF info file on libvisual. It is attached.

2. Hearing
No aural detection in DI SAF.

3. Other senses--none.

4. Movement
a. Walking, running, crawling
i. Default speeds--DISAF currently produces only standing and prone states, so these values are inapplicable.
ii. Speeds affected by terrain slope, soil type, etc.--The current body model has parameters for maximum movement rates in different postures on different soil types. These are described in the attached *libdi* document. I don't know about slope effects; there may be something buried in the code.
iii. Ford streams-- the above *libdi* file mentions shallow or deep water. I don't know if it is actually possible to make DI SAF IC's go into deep or shallow water.

b. Rolling, climbing, etc.--Not supported.
c. Able to look in a direction different from moving--yes.
d. Collision testing--based on a simple bounding volume of some sort; not sure how it works. Certainly does not consider individual limbs.

5. Postures.
Only standing, kneeling, and prone are supported at the moment.

6. Gestures--none.

7. Hit damage assessment-- Based on tank damage assessment. Results in mobility, firepower, or catastrophic kills. The mechanism is described briefly in the info file for *libdfdam*.

Sensor Models
1. Types supported:
a. Passive--only visual will be used for ICs for now.
b. Active--none will be used for now.

2. Dynamic field of view adjustment--none. (Not physically realistic for direct human vision)

3. Resolution adjustments--none.

4. Impact on target acq models--the sensor characteristic plays a big part in acquisition. See libvisual.

5. Combat identification simulation--Identification of types is part of the acquisition model. Identifying individuals is not supported.

Weapon models
1. Weapon types supported--for milestone 1, M16A2 and AT8.

2. Ballistic model--none. P(Hit) tables used. Effective range of M16 is given as 500m.

3. Munition types- For M16, the M855. For AT8, ? (whatever we said in the DIS enumeration doc.)

4. Sensors--visual only.

Display--NA.

Boston Dynamics – DI-Guy

1. Standard travel speeds:

ACTION	SPEED (m/s)
Crawl	0.38
Walk	0.67
Jog	1.87
Walk Crouched	0.50
Walk Back	-0.45
Walk Back Crouched	-0.61

2. Action Transition Times (in seconds):

We have grouped all actions into standing, kneeling, and prone postures to get approximate transition times:

TRANSITION	TIME (S)
Standing -> Kneeling	2
Kneeling -> Standing	1.8
Standing -> Prone	5
Prone - > Standing	4.5
Kneeling -> Prone	5
Prone -> Kneeling	4.5

3. Eye height in three postures.

POSTURE	EYE HEIGHT (m)
Prone	0.35
Kneel	1.24
Stand	1.73

Notes:

1. The DI-Guy user can adjust travel speed upward and downward as required. The speeds given in the tables are the most natural-looking speeds for DI-Guy. The same is true for transition times.

2. The speeds and transition times given above are for DI-Guy with size scale = 1.0. When DI-Guy is scaled by a factor F, the natural speeds and transition times are both scaled up by Sqrt(F). For example, if the user creates a DI-Guy with size scale = 1.1, the optimal travel speeds would be about 1.05 times and the transition would each take about 1.05 times longer.

3. Eye height scales linearly with DI-Guy's size scale.

SAIC – Task Analysis SME Response

SUBJECT: Mobility Rates for Individual Combatants

PURPOSE: A discussion paper on the relative mobility characteristics of individual combatants engaged in urban warfare in buildings.

BACKGROUND: DI-SAF needs set of consistent rates that can be used for representing the movement of an assault team in an urban environment. Currently, three maximum rates are included in DI-SAF based on posture (standing, kneeling, prone). There are rates associated with different soil types (road, RC1050, RC1250, shallow water, deep water). A energy consumption rate and a recovery rate are identified. Maximum percent slopes for dry and wet terrain are included.

Other constructive models (IUSS, Janus (soldier station), CCTT DIM) utilize several additional factors to set the rate at which ICs move in the synthetic environment. IUSS contains the most detailed number of factors and controls movement through a physiological model of the IC. The physiological model includes a number of IC factors such as core temperature, humidity, permeability of clothing, etc., that affect energy expenditure of the IC. Other factors include previous activities conducted by the IC, as well as load carried, terrain slope, terrain types and environmental conditions. Several algorithms for calculating energy expenditure created by USA Research Institute for Environmental Medicine (USAREIM) have been included in IUSS. The output of the physiological model in terms of energy expended and core temperature allows final movement rates to be established for the IC.

CCTT-SAF Dismounted Infantry Module utilized the IUSS model to create a series of curves or response surface that related several of these factors to each other. The response surface was used to set movement rates in the DIM. This approach is also being used to include DIM module in the UK CATT project for the British Army. Energy expenditure calculations are being modeling using 1970 to 1977 Journal of Applied Physiology articles as basis for implementation.

Janus uses the AMSAA AMC71 Mobility Model for moving all entities in the synthetic environment. It does not apply a fatigue factor or calculate fatigue directly, but include reductions in other rates to account for it. Mobility model is set with maximum/minimum speeds over various terrain types. Degradations are applied for specific terrain conditions such as forests (slow down rate to account for moving and avoiding trees), cross country/off road. Janus also includes terrain slope and does differentiate movement in urban area. In addition, there are several distinct movement statuses that require separate degradations. These include obstacles such as fences, walls, ditches that hinder movement. Suppression is also applied and suppressive fire causes ICs to go prone with zero movement rate. Janus represents the same three postures as does IUSS and other models. It does not allow movement while in kneeling posture (assumes kneeling takes place in foxhole or bunker where movement cannot occur).

Standing posture includes walking forward and backward and running. Prone includes the same forward or backward movement. A crouching posture is also allowed.

FACTORS AFFECTING MOVEMENT

Slope	Calculated from rise in elevation over distance traveled.
Load	Input or assumed. Standard combat load (FM 21-18) is 48 pounds. Road march (approach march may be as high as 72 pounds). Note the Land Warrior specification is assuming 75 pounds as load on IC for design purposes.
Terrain Type	Uses mobility model classification for different types of terrain. MODSAF and CCTT-SAF were set to use WES mobility model of terrain types. Janus uses AMSAA AMC71 mobility model
Weather	Dry or wet causes reduction in trafficability
Time of Day	Rates differ. Road march rate is 4 KPH in day; 3.2 at night or limited visibility; Cross country rates are 2.4 and 1.6 KPH respectively (FM 21-18 Road March)
Other	Core temperature, humidity, permeability, previous activity - all used in IUSS
Energy expenditure	Calculated from algorithms (IUSS) or factored with rates (MODSAF)
Behavioral Factors	Fear, suppression, morale are not currently modeled in any CGF. Articles on suppression have been presented at CGF Behavior Conferences. Janus does address suppression effect on movement.

NOTE: Forced marches are those conducted to move groups of soldiers longer distances. The current practice is to retain the standard march rate, but increase the number of hours per day from 8 to 10. Therefore, conditioned troops can be expected to move 32 kilometers in a standard day and up to 48 kilometers under forced march conditions. Historical examples of longer movements abound (Grant, Jackson, Anzio, Roman legions).

The factors displayed in the table above should not be considered all inclusive, but representative of those needed to simulate movement of ICs in synthetic environment. It is clear that terrain type, slope, load and environmental conditions affect the speed of movement. It is also clear that the physiological factors affecting the IC also are important. How they are included in movement rate calculation is unclear for DWN. Current methodology in DI-SAF to be used in the absence of other information.

IUSS is being used by constructive model team at AMSAA to prepare for MOUT ATCD. There is no clear or single, driving factor that can be used in the absence of all others. All must be accommodated in some manner to represent movement of ICs. The movement under conditions of improved equipment and other IC capabilities become more important as new equipment enters the inventory.

MOVEMENT RATES IN URBAN ENVIRONMENT

Movement in urban areas must take these factors into account as well. Movement outside of buildings can easily use the standard rates used for cross country or paved roads. Movement in buildings is more complex and is addressed separately below.

TYPES OF RATES IN URBAN ENVIRONMENT FOR CGF

There are at least four different rates of movement in buildings that need to be accommodated or represented. These are movement in hallways, movement into rooms, movement after clearing operation within the room, and movement in stairwells. Each will be discussed separately below.

Building Environment

Buildings are characterized by hallways or corridors and connecting rooms. Multiple floors in buildings are connected by stairwells. Cellars present a special case where subterranean movement conditions must be considered. Hallways and rooms are normally flat with no elevation rise. Therefore, a terrain type can be selected that is flat and level, similar to paved roadways. There is no grade to worry about except in stairwells. Environmental conditions may cause reductions in ability of IC to move. Trafficability e.g. may be affected by heat inside buildings from fires or lack of air conditioning in hot climate. These environmental conditions, at least theoretically, would cause modification in IUSS movement, but not necessarily in any other CGFs. In some instances, obstacles may be formed by debris in path of ICs. Last, but not least, is the need to move while expecting enemy contact at any time.

Movement in hallways.

Movement down hallways is performed by 4-man assault teams. The movement is conducted with ICs moving with weapons at the ready, aimed in the direction of their specific sectors of observation. The weapons move from side to side as the IC moves his head to cover the sector. The movement down a corridor or hallway is performed in a loose formation of four IC with three facing forward and one to the rear. The rate for this formation would appear to be limited by the rate at which the rear IC can move backwards; the forward rate is less than normal walking rate. Therefore, the backward walking rate can be used as the maximum forward speed for the assault team in clear hallway formation.

Movement in Rooms.

Entry into the room and within the room may be undertaken at faster speeds than normal walking or hallway clearing. Entry into a room is undertaken as a rush and should be represented by fast movement. The upper limit for the rush should be the same as rushing from covered and concealed position to the next in open terrain. This rate is 10 to 20 meters in 3 to 5 seconds or speeds ranging from 3.33 meters per sec (10 meters in 3 sec) to 6.66 meters per second (20 meters in 3 sec). As this rate cannot be sustained for more than short distances, it can be used in a room as well as outside in the assault. Note that physical conditioning standards for soldiers require them to run 8 minute miles (FM 21-20 or 3.33 meters per second. NOTE: The upper limit of 6.66 is close to current NCAA record for 1500 meters (6.85 meters per second) and is much to high to support IC movement. A 6 minute mile rate (4.44ms) can be used. Burst speed NCAA records for 100, 110 hurdles, 200, 400 and 400 hurdles are 10ms, 8.195, 9.925, 8.992 and 8.144 ms respectively. It is obvious that records are run unencumbered by combat loads.

Entry into Buildings.
Again, this can be represented with movement of the team as a rush if the aperture or opening permits the IC to enter standing up. If the IC must crouch or crawl to entry the opening, then the rate must be adjusted downward. Crawling rates for prone posture are included in DI-SAF. It remains to be seen if the rates are reasonable.

Movement in Stairwells.
The rate at which ICs climb or descend stairs is purely judgmental. The rise in elevation between floors is not the same as terrain slope, but energy expenditures for soldiers in combat loads moving up a staircase should be calculated. Movement up the stairwell is conducted cautiously and not in accordance with some fixed rate due to the potential for enemy contact. Use of grenades is normal and safety in throwing them up versus down a stairwell is paramount. A new USMC manual on Military Operations in Urbanized Terrain points out that Marines go up a staircase with two men leading from the assault team. The first goes part way, as far as needed to see the top of the stairwell, and turns around backwards to search upwards. The second person takes over the previous sector (forward) and the two move up the staircase in tandem until they reach the top. This allows security in both directions while transiting the staircase.

SUMMARY

The appropriate method for setting rates in simulations is to request specific data from US Army Material Systems Analysis Agency (USA AMSAA) to ensure that approved or standard performance data is used. It is not clear if rates have been determined from ARI or TECOM tests of equipment that would be usable. AMSAA analysts intend to obtain some data during MOUT ACTD tests to modify IUSS rates. At the present time, no database of rates for movement in building exists, hence reasonable judgments need to be made to assist in selecting rates that (1) appear credible to military customer and (2) have some validity in fact. The speeds at which the ICs move should be credible. In the absence of specific information provided by the Army, the following maximum movement rates are offered for consideration.

MAXIMUM MOVEMENT RATES FOR USE IN BUILDINGS

Posture	Rate	Meters per second	Reference
1. Standing			
1.1Walking forward	3.2 to 4.0 KPH	0.888 to 1.111 ms	Night and Day road march rates; (FM21-18)
1.2 Walking backward	1.6 to 2.4 KPH	0.444 to 0.666 ms	Uses cross country rates for day and night. (FM21-18)
1.3 Running /rushing	12.0 to 16.0 KPH	3.333 to 4.444 ms	Uses 8 minute mile criteria for soldier PT conditioning standard and 3 seconds to cover 10 meters or 20 meters from individual task describing seeking cover and concealment (FM 21-20; STP-21-1-SMTP).
1.4 Entering Room	12.0	3.333 ms	Adapt rushing rate to room entry; may reduce to account for more control than independent rush.
1.5 Walking in Quick Kill Posture (Hallway movement)	2.4 to 1.6 KPH	0.666 to 0.444ms	Adapt cross country day and night rates to building movement; assumes more control over formation is needed. Forward movement dictated by capability of rear IC to move backwards.
1.6 Stairwell Movement	1.6 KPH	0.444 ms	Adapt cross country night rate to account for movement of ICs up or down stairs with security in both directions (backward movement of assault team)
2. Kneeling	0 KPH		Matches Janus input data, but does not allow for crawling through apertures where high crawl postures is needed. Considers posture for foxholes or static positions only.
3. Prone			
3.1 Prone Forward	.5 KPH		No change from DI-SAF inputs; Information not available to set different rates.
3.2 Prone Backward	.5 KPH		No change from DI SAF inputs. Information not available to set different rates.

APPENDIX B: DWN ERT Experiment Plan

ADVANCED DISTRIBUTED SIMULATION TECHNOLOGY II (ADST II)

DISMOUNTED WARRIOR NETWORK ENHANCEMENTS FOR RESTRICTED TERRAIN (DWN ERT)

Experiment Plan

15 September 1998

BY: Lockheed Martin Corporation
Information Systems Company
12506 Lake Underhill Road
Orlando, Florida 32825

TABLE OF CONTENTS

1.0 Introduction

This document defines the plans for the execution of the experiments conducted as part of the ADST II delivery order Dismounted Warrior Network (DWN) Enhancements for Restricted Terrain (ERT) (DO #0055). The experiment effort is specified in the DWN ERT Statement of Work paragraph 3.1.3.2. This document is not a CDRL item but is a necessary part of the planning process. This version has been modified to reflect what actually occurred during the experiments. Thus, the date of this plan is after the dates of the experiments.

The major thrust of the overall DWN effort is to develop a set of requirements for dismounted infantry (DI) simulation to support both the Training, Exercises, and Military Operations (TEMO) and the Advanced Concepts and Requirements/Research, Development, and Acquisition (ACR/RDA) domains. The DWN follow-on ERT phase builds upon the lessons learned from the previous DWN effort and focuses on restricted terrain applications, specifically military operations in urban terrain (MOUT).

The original DWN engineering and follow-on user exercises were more expansive than the current efforts, covering a total period of six weeks versus the current two-week effort. This experiment plan allocates one week for engineering experiments and one week of mission-oriented user exercises, in accordance with the plans briefed at the DWN ERT technical interchange meetings (TIMs).

2.0 Purpose

The DWN ERT experiments are intended to compare and contrast the ability of the key features of different Virtual Individual Combatant (VIC) technologies to support DI task performance in a virtual MOUT environment. The intent of comparing these different technologies over different tasks is to document the capabilities of each in order to be later matched against functional fidelity requirements flowing from the fidelity analysis portion of the original DWN effort. The result is the beginnings of a catalog that match existing technologies and capabilities against simulation requirements, and the identification of areas where future technology development is required.

3.0 DWN ERT System Description

In the original DWN effort, preliminary technology analyses conducted prior to the award of the DWN contract help to define the VICs that would ultimately participate in the DWN experiments. The VICs were selected to represent a cross section of current-technology capability within a variety of functional areas important to DIS-based DI simulation. No development was performed under the DWN effort except as required to fulfill the objectives of the experiments and to insure interoperability among systems. In this ERT phase of DWN, a similar approach has been taken. Existing systems have been selected that represent enhancements or growth beyond the original DWN systems, improving specific areas that were determined to be shortfalls based on the results of the DWN experiments. Examples include improved visual system resolution and field of view (FOV) and increased system update rates. Again, system modification under DWN ERT has been limited to changes required to achieve interoperability or to support experimental objectives, such as adding dynamic terrain capabilities.

In keeping with existing DWN nomenclature, the participating VICs have been assigned generic alpha tags as identifiers. The four VICs participating in the DWN ERT experiments are Alpha, Delta, Echo, and Golf. The overall system layout is shown in Figure 3-1. The characteristics of these VICs are summarized in Table 3-1. As before, all the VICs are DIS-compliant simulators. They are described in more detail in the following sections.

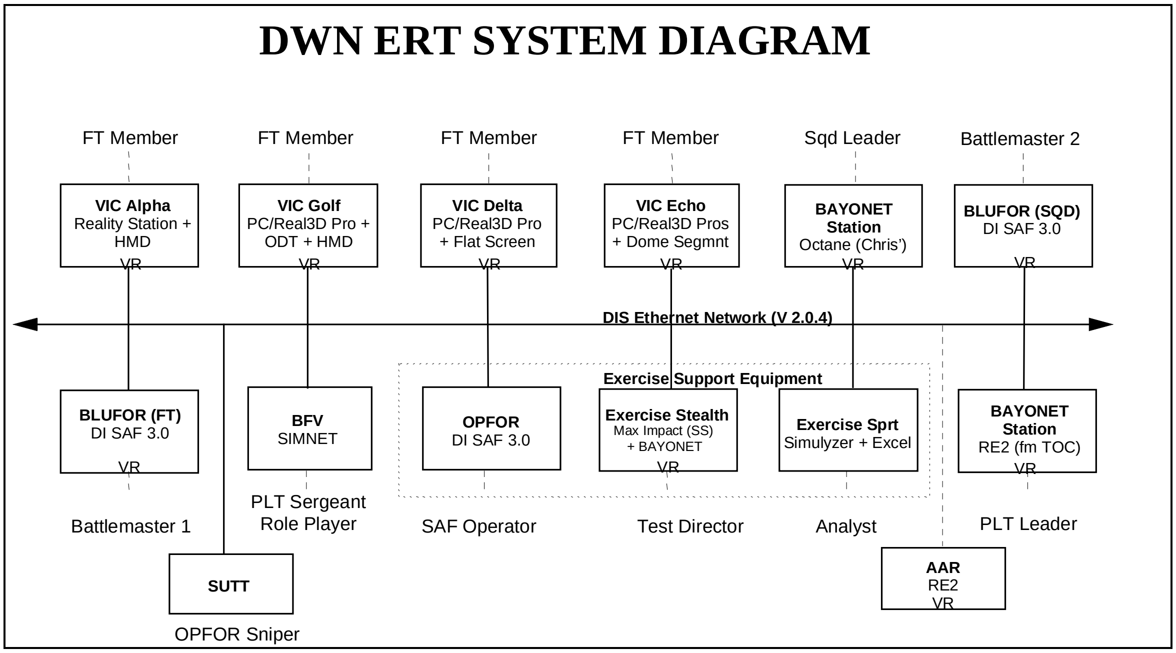


Figure 3-1.

3.1 VIC Alpha

VIC Alpha consists of the Veda, Inc. Dismounted Soldier System (DSS). The DSS participated in the original DWN experiments also under the name of VIC Alpha. DSS characteristics are summarized below:

- Video based full body motion tracking (Biomechanics)
- SGI RE2 Image Generator
- Wireless Helmet Mounted Display
- M-16 Weapon Simulation (GFE from NAWCTSD)
- Omni-directional Sound
- Biomechanics-based human animation figure
- DIS PDUs with human animation enhancements

Table 3-1. VIC Comparison Matrix

Function	VIC Alpha	VIC Golf	VIC Delta	VIC Echo
Locomotion	Weapon Mounted Joystick	Alternatives: i) ODT or ii) Weapon Mounted Thumbswitch	Weapon Mounted Thumbswitch	Weapon Mounted Thumbswitch
Visual Display	• 45° x 34° FOV HMD • < VGA resolution (230 x 789)	• 100° x 50° or 65° x 50° FOV HMD • VGA resolution (640 x 480)	• 90° x 60° FOV (nominal) projection display • VGA or SVGA (800 x 600) resolution	• 150° x 40° FOV projection display • VGA resolution side channels, 1024 x 768 resolution center
Body Motion Capture	Video (position and orientation)	ODT harness for body position and orientation, Inertial for head tracking (orientation)	Ultrasonic (position only)	Ultrasonic (position only)
Weapon Tracking	Video	Inertial + acoustic	Inertial + acoustic	Inertial + acoustic
Weapon Aiming	IHAS (Video insert)	'Virtual rifle' + 'Virtual IHAS'	IHAS (Integrated Helmet Assembly Subsystem)	IHAS
Directional Sound	SoundStorm 3D	SoundStorm 3D	SoundStorm 3D	SoundStorm 3D
Human Animation	Biomechanics	DI Guy	DI Guy	DI Guy
Comms	• Virtual Radio	• Virtual Radio	• Virtual Radio • DI C4I	• Virtual Radio • DI C4I

Relevant VIC Alpha system enhancements since the previous DWN experiments include:

- Non-visible lights for video tracking system
- Dynamic terrain capability
- Mobility control using wireless weapon-mounted joystick instead of hip direction and concentric circles
- Increased system robustness
- Enhanced DI animation
- Higher resolution wireless HMD
- Video IHAS (Integrated Helmet Assembly Subsystem - a simulated Land Warrior device that presents a weapon sight/scope view on a monocular helmet-mounted display) for weapon aiming

3.2 VIC Delta

The remaining three VICs have as their core the Soldier Visualization Station (SVS) developed by Reality by Design (RBD). The basic SVS consists of the following:

- Two Pentium PCs with a 3D graphics board and sound card with speakers
- RBD's proprietary SVS software
- InterSense hybrid inertial/acoustic tracker for body (head) position and weapon pointing tracking
- Simulated Land Warrior M-4 weapon
- IHAS Display (VGA)
- Single LCD projector (VGA) with 8 x 10 foot screen
- DI-Guy human animation

SVS tracks user position and modifies the displayed FOV as the user gets nearer or farther from the screen. Weapon aiming is provided either through the IHAS view or by weapon sights. VIC Delta is basically an SVS with a Real3D Pro graphics accelerator that is intended to provide greater update rate (30 Hz minimum goal) and either VGA or SVGA resolution.

3.3 VIC Echo

VIC Echo consists of an RBD SVS system with a modified display subsystem. Two Real3D Pro graphic accelerators drive three high-resolution projectors that display the SVS imagery onto a 150° x 40° dome segment display. This display surface is curved, shaped as if a rectangular piece had been cut from a spherical aircraft simulator dome display. One Pro drives the central 50° x 40° at an XGA resolution of 1024 x 768 while the second Pro drives the two peripheral 50° x 40° sections at VGA resolution. All other components of the SVS are also in place.

3.4 VIC Golf

VIC Golf is comprised of the integration of SVS, less the baseline display component, the Omni-Directional Treadmill (ODT), a legacy system from DWN, and the Kaiser ProView 80 high resolution head mounted display (HMD). These latter two subsystems are described below:

- ODT (Omni-directional Treadmill)
  - Developed by Virtual Space Devices for STRICOM
  - Supports 360° directional locomotion
  - Originally developed for use with the walk-in synthetic environment (WISE) display system
  - Un-modified from the DWN configuration
- Kaiser ProView 80 HMD
  - Binocular display capable of 100% overlap mono- or stereoscopic display with 65° x 50° FOV
    - Partial overlap of 30° provides 100° x 50° FOV
  - VGA resolution using full color LCDs as image sources

A Real3D Pro provides two channels of VGA video to drive the HMD display. RBD has modified its SVS product to interface with and control the ODT. An additional inertial sensor has been added to track the orientation of the user's head to control his view into the database. The SVS weapon provides additional controls to select the user's posture between standing, kneeling, and prone.

3.5 Support Capabilities

Supporting the VIC network for the DWN experiments will be DI SAF stations under development by SAIC, a several BAYONET stations to provide role player stations and to generate target entities, an After Action Review system, and an Exercise Support Station. This latter station will use the *Simulyzer* software to collect DIS PDU data and perform real-time system monitoring during the experiments. Additionally, NAWC/TSD's Small Unit Tactical Trainer (SUTT), formerly known as TTES (Team Tactical Engagement Simulator), was intended to provide a manned OPFOR sniper capability. SUTT, a participant during the original DWN experiments as VIC Foxtrot, was not able to participate during the DWN ERT exercises, so the manned OPFOR sniper was implemented using a BAYONET simulator, described below.

3.5.1 BAYONET

The BAYONET tabletop manned simulator consists of the following:

- Based on heritage NPSNET software with additional capabilities added by RBD (e.g., dynamic terrain)
- Desktop CRT display
- Joystick movement control via flybox or keyboard controls
- Directional Sound
- DIS Compliant
- DI-Guy animation model replaces JackML

BAYONET stations will provide role player stations for the squad and platoon leaders, will provide a stealth monitoring capability for the exercise director, and will be used as the visualization component of the after action review (AAR) system.

3.5.2 DI SAF

The dismounted infantry semi-automated forces (DI SAF) being developed by SAIC for the DWN effort will provide supporting BLUFOR to the VICs during the user exercises, as well as providing an OPFOR squad during these exercises. The DI SAF will also be the object of investigation during the experiments to assess its performance during both portions of the experiments (engineering and USEX).

3.5.3 Exercise Support Station

As before, Simulyzer, hosted on a Silicon Graphics machine, will be used for PDU data collection. Logger files will also be created for replay during AAR. Off-line analysis of the PDU data will be performed using Excel and PC-based statistical analysis software.

3.5.4 After Action Review Station

The AAR system will be composed of a Simulyzer station for replay of PDU logger files and a BAYONET station for visualization.

3.55 Small Unit Tactical Trainer

Again, SUTT was unable to participate and was replaced by a BAYONET station.

4.0 Data Measurements

Prior, during, or after the experiments, two types of data will be collected (time permitting) to characterize the VIC and SAF systems: model parameter data and engineering measurements.

4.1 Model Parameters

All of the VICs, and of course the DI SAF to an even greater extent, contain some component models of human or subsystem behavior, whether in terms of movement rates, visual acquisition models, weapon models, etc. A questionnaire was submitted to the developers of all the VICs and the DI SAF to define specific model parameters. This was used to ensure interoperability as well as to characterize the systems. This questionnaire is presented in Figure 4.1-1. The results of these questionnaires will be reported in the DWN ERT final report. They have been discussed at DWN ERT technical interchange meetings to arrive at common parameter values where this effects interoperability.

4.2 Engineering Measurements

Based upon availability of time and equipment, data measurements will be made on the VICs to characterize these systems in terms of latencies, tracker accuracies and stability, etc. Engineering measures relevant to specific experimental tasks are discussed in the next sections.

Human (Dismounted Infantry) Models

1. Vision
   a. Detection/acquisition model - Field of view, range effects, environmental effects, eye height
2. Hearing
   a. Modeled for SAF? If so, parameters of model.
   b. Presentation to user: directional (stereo) or spatial (3-D)
   c. Sounds to be generated (e.g., walking?)
3. Other senses modeled?
4. Movement/locomotion:
   a. Walking, running, crawling
      i. Default speeds
      ii. Speeds effected by terrain slope, soil type, etc.?
      iii. Ford streams and other shallow water terrain?
   b. Other behaviors such as rolling, climbing that support surmounting obstacles?
   c. Able to look in a direction different than the one moving in (while moving)?
   d. Collision testing: bounding volumes, variable depending on posture or extending limbs, e.g., arms?
5. Postures: Standing, kneeling, prone, crouching, . . .
6. Gestures: List gestures supported (generation VICs and SAF, recognition SAF)
   a. VIC generation: continuous user movement tracking or canned motion?
7. Hit damage assessment: wound/kill models or algorithms

Sensor Models

1. Types supported:
   a. Passive: NVG (I^2), IR, optical
   b. Active: Laser, IR aiming dot, lights
2. Dynamic field of view adjustment?
3. Resolution adjustments?
4. Impact on target acquisition models?
5. Combat identification simulation?

Weapon Models

1. Weapon types supported
2. Ballistic model(s): effective ranges
3. Munitions types and effects
4. Sensors associated with weapons for sighting/aiming (scopes, IR aiming dots, etc.)

Display

1. Differential display of entities based on detection/recognition status?
2. Level of detail for models; range filters; dynamic LOD, e.g., for animation of DI models.

Figure 4.1-1. Model Parameter Questionnaire

5.0 Engineering Experiments

5.1 General Requirements

The engineering experiments will be run using VICs Alpha, Delta, Echo, and Golf as the manned subsystems under test, with BAYONET workstations providing target and other support entities as required. All subsystems and workstations will be networked together using DIS 2.0.4 communication protocols. *Simulyzer* data logging and analysis software located on the Exercise Support Station will be used for data collection (PDU logging) and summarization. *Simulyzer* has the capability to output ASCII data files, which will be loaded into Excel software on a PC for further analysis.

In addition to *Simulyzer* data collection, the following data collection/logging capabilities will be required:

- Input header information for data files including:
  - Subject identifier for each VIC
  - Date/time
  - Test conditions
  - Run/trial number
- Measure system parameters (identified below for each functional test area) during system integration
- Administer questionnaires including:
  - TBD

It is also required that experimental trials can be initiated, monitored, and terminated (if required) from the Exercise Support Station terminal. This control will be exercised over the administrative communications net by verbally commanding the system operators at the other workstations and VICs to start, stop, etc.

During the DWN experiments, the use of ModSAF to generate targets proved to be problematic. Target (scenario) file creation was tedious, execution during the experiments was operator-intensive and time consuming and didn’t permit accurate timing of trial initiation. Since all targets planned for use during the DWN ERT engineering experiments are DI models, current plans are to use software specifically developed for DWN to generate DI entity targets. One BAYONET station will be used for each VIC, with each VIC-BAYONET pair running with a different exercise identification number so as to be invisible to the other three VICs. Logical reassignment of the VIC-BAYONET pairings will control target presentation order.

The following sections provide descriptions of the experimental tasks, the data collection requirements, performance measures, and database requirements for each of the test areas including locomotion, visual search and target acquisition, and weapon aiming,

5.2 Locomotion Experiments

The basic purpose of the locomotion experiments is to determine how well the VIC mobility component allows navigation through the virtual environment. This will be assessed by requiring the subjects to navigate through a building within the McKenna MOUT database.

5.2.1 Tasks

The basic task for the locomotion experiments is for individual participants to negotiate a single or multiple courses inside of building interiors in the McKenna MOUT database.

The courses will not be difficult to learn (in fact, it may provide no choices as to direction), but it will require frequent changes in direction, changes in movement speed, going up and down stairs, and movement through confined areas, such as going through doors and hallways. Soldiers will be instructed to complete the course as quickly as possible but not at the cost of moving so quickly as to increase the number of collisions with building structure or other objects.

Design considerations for these experiments include:

- Eight repetitions of this task will be performed over the course of a week by each soldier on each VIC
- Course used for data collection will be through Building A of the McKenna database

5.2.2 Data Requirements

Prior to the experiments, system parameters including the following will be measured and recorded:

- Controller sensitivity (output per unit input), deadbands, hysteresis
- Maximum output (movement rates)
- System lag (control input through visual system)

Data to be logged for the locomotion/obstacle avoidance tasks includes:

- Simulation time (seconds)
- DI position and orientation in database (1 foot resolution)
- Collision events

Subjective data from post session debriefs and questionnaires listed in Section 5.1 will also be collected.

5.2.3 Performance Measures.

The data collected will support the assessment of the following measures:

- Plot of DI position vs time
- Course or course segment completion time
- Number of collisions
- Change in proficiency over time

5.3 Target Search and Engagement Experiments

These experiments will be conducted to assess how well the VIC visual and weapon system components allow the search for and the detection and acquisition of DI targets in the virtual environment. The visual system component will assess how well the VIC visual systems support the scanning for and detection of DI-sized targets at ranges out to 150 meters. The weapon aiming component will be conducted to assess how well the VIC weapon tracking and visual system components allow the acquisition and engagement of objects in the virtual environment. This will be assessed by requiring the subjects to locate, track, and shoot at static and moving targets.

Two tasks will be performed to assess how well the VICs allow users to locate and engage DI targets. The first focuses primarily on the visual and weapon systems; the second includes the locomotion subsystem as well.

5.3.1 Task 1 - Visual Search and Engagements

Individual participants standing in a fixed position will attempt to locate DI targets and engage them with their weapons. A specially constructed dish-shaped database will be used for these trials. The flat portion of the dish has a radius of 150 meters for target placement. Targets will be presented anywhere within the forward 270 degree field of regard (±135°). Both stationary and moving targets will be included.

A total of 48 trials will be conducted for presentation of the stimuli for this task: 1 target class (infantry) x 4 distances (25, 50, 100, 150 meters) x 3 speeds (0, 4, 8 mph) and stationary) x 4 azimuths (230°, 315°, 80°, 130°) (see Figure 5.3.1-1). A full factorial combination of these values was used to generate the 48 trial conditions.

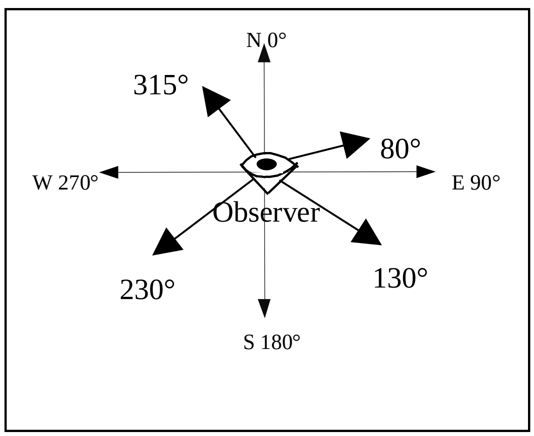


Figure 5.3.1-1. Azimuth Locations Relative to Observer

5.3.2 Task 2 - Locomotion, Search, and Engagement

In this task, the subjects will be moving through the environment looking for DI targets. Once located, they will be fired upon as a recordable signal that they have been located. Two search environments will be used: 1) Inside of Building A of the McKenna database, and 2) Along the streets of the McKenna database. The first environment will encourage fast side-to-side scanning for targets at close ranges (inside rooms); the second will involve more vertical scanning as well, since targets can be placed at windows on the second and third floors of buildings as well as on rooftops.

The basic task will be for the soldiers to follow a defined course (or to search the entire building) and look for DI targets. These targets will be stationary and non-reactive.

Exact numbers and locations of targets will vary from trial to trial to eliminate learning of target locations.

5.3.3 Data Requirements

Prior to the experiments, system parameters including the following will be measured and recorded:

- Resolution (acuity measured via system display),
- Field of view, subject viewing distance from display
- Update rates
- Tracking system resolution and repeatability (reliability)
- System lag (control input through visual system)

Data to be logged for these tasks include:

- Simulation time (seconds)
- DI position in database (fixed position)
- Target position, range, and orientation from the subject; line-of-sight (LOS)
- Target detection and identification events (trigger pull/button press)

Weapon aiming system performance measures include:

- Time to engage, number/percent of targets successfully engaged
- Accuracy (hit location or miss distance)
- Engagement time

Subjective data from post session debriefs and questionnaires listed in Section 5.1 will also be collected.

5.4 Weapon Aiming Posture Experiment

The weapon aiming experiments will be conducted to assess how well the VIC weapon tracking and visual system components allow the acquisition and engagement of DI targets in the virtual environment from standing, kneeling, and prone postures.

In general, the settings for the previous engagement task (Section 5.3.1) will be appropriate. All targets will be engaged from the kneeling, standing, and prone positions. All targets will appear in the initial field of view, i.e., within ±25° of the initial line of sight. Forty-eight (48) targets will be used for this task: 3 postures x 4 ranges x 4 azimuths (345°, 355°, 10°, 20°) x 1 speed (0 mph) = 48 targets, 16 per posture.

5.4.1 Data Requirements

Prior to the experiments, system parameters including the following will be measured and recorded:

- Tracking system resolution
- Repeatability (reliability)
- Update rates, system lag (control input through visual system)

Data to be logged for the weapon aiming tasks includes:

- Simulation time (seconds)
- DI position in database (fixed position)
- Target position, range, and orientation from the subject; LOS
- Weapon firing events (trigger pull/button press)
- Target hit/miss results (where on target hit; miss distance in target plane)

Subjective data from post session debriefs and questionnaires listed in Section 5.1 will also be collected.

5.4.2 Performance Measures.

Weapon aiming system performance measures include:

- Time to engage, number/percent of targets successfully engaged
- Accuracy (hit location on target or miss distance)
- Engagement time

5.5 Engineering Experimental Design

Due to the limited availability of subject matter expert (SME) subjects (soldiers), a repeated measures design will be employed. Thus, all subjects will experience all conditions on all VICs. All analyses conducted will be appropriate to this design, and will consider the limited sample on which the data will be collected.

5.5.1 Subjects

Eight (8) active-duty US Army Infantry soldiers have been requested from Ft. Benning, Georgia, plus two additional for the USEX portion of the experiments for the squad and platoon leaders. It is assumed that the same soldiers will be available throughout the experiments, including a few days prior to the engineering experiments for VIC familiarization. These 8 soldiers will be randomly paired into four groups, and each group will be presented with the same conditions over time. Within each group, soldiers will alternate sessions on the VIC in order to minimize fatigue effects. Each group will experience all four VICs during the experiments.

All restrictions and safety consideration concerning the use of human subjects and the use of military personnel on (potentially) non-safety certified equipment will be addressed prior to allowing the subjects to use any of the equipment.

5.5.2 Counterbalancing

Since all subjects will experience all four VICs, the order of presentation of the VICs between groups of subjects should be balanced to the extent possible. This counterbalancing scheme for the four groups and the four VICs is presented in Table 5.5.3-2 below. Participant numbers (Soldiers (S) 1-8) are shown in the cells. Each pair of participants uses each VIC twice each day.

5.5.3 Schedule

The engineering experiments are scheduled to take place over a one week period July 13 - 17 1998. The overall DWN ERT experiment schedule is shown in Table 5.5.3-1. The engineering experiment schedule with subject/VIC assignments is shown in Table 5.5.3-2. This schedule provides only four test days with one day for McKenna MOUT on-site activities (see Section 8), and includes VIC familiarization training. This schedule assumes an eight-hour workday, since experience indicates that workdays usually grow longer rather than shorter, and to plan for more invites the potential for overtaxing support personnel as well as the subjects.

Table 5.5.3-1. Overall Experiment Schedule

<table>
<tr><th colspan="7">DWN ERT Experiment Schedule
July 1998</th></tr>
<tr><th>Sunday</th><th>Monday</th><th>Tuesday</th><th>Wednesday</th><th>Thursday</th><th>Friday</th><th>Saturday</th></tr>
<tr><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td></tr>
<tr><td></td><td colspan="2">Soldier Training</td><td colspan="3">Pre-Experiment Integration</td><td></td></tr>
<tr><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td></tr>
<tr><td></td><td colspan="3">Engineering Experiments Data Collection</td><td>Live Tests (McKenna)</td><td>Data Collection</td><td></td></tr>
<tr><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td>24</td><td>25</td></tr>
<tr><td></td><td colspan="3">USEX Training and Data Collection</td><td>Media Day</td><td>Aiming Tests</td><td></td></tr>
</table>

The current experiment schedule shows four days of integration (including Saturday) prior to testing. Soldiers arrived earlier in the week and received VIC familiarization and training for a demonstration for Newt Gingrich scheduled for Friday the 10^{th}. Weekends are set aside for system maintenance and session make-ups as required. The last day of each set of experiments was to be used for live data collection at the McKenna MOUT site, but all McKenna MOUT activities were conducted on the morning of Thursday the 16^{th}. Fridays were used for final experiment data collection, and post-experiment debrief and completion of questionnaires.

Table 5.5.3-2. Engineering Experiments Schedule

DWN ERT Engineering Experiments Schedule July 1998																				
	Monday 13th				**Tuesday 14th**				**Wednesday 15th**				**Thursday 16th**				**Friday 17th**			
Time	**A**	**D**	**E**	**G**	**A**	**D**	**E**	**G**	**A**	**D**	**E**	**G**	**A**	**D**	**E**	**G**	**A**	**D**	**E**	**G**
0800	Soldier Briefing and Training				S4	S1	S2	S3	S2	S3	S4	S1	Live at McKenna				S5	S6	S7	S8
0830					S8	S5	S6	S7	S6	S7	S8	S5					S1	S2	S3	S4
0900					S1	S2	S3	S4	S3	S4	S1	S2					S6	S7	S8	S5
0930					S5	S6	S7	S8	S7	S8	S5	S6					S2	S3	S4	S1
1000	S1	S2	S3	S4	S3	S4	S1	S2	S5	S6	S7	S8					S8	S5	S6	S7
1030	S5	S6	S7	S8	S7	S8	S5	S6	S1	S2	S3	S4					S4	S1	S2	S3
1100	S2	S3	S4	S1	S4	S1	S2	S3	S6	S7	S8	S5					S5	S6	S7	S8
1130	S6	S7	S8	S5	S8	S5	S6	S7	S2	S3	S4	S1					S1	S2	S3	S4
LUNCH BREAK																				
1300	S3	S4	S1	S2	S1	S2	S3	S4	S7	S8	S5	S6	S8	S5	S6	S7	S6	S7	S8	S5
1330	S7	S8	S5	S6	S5	S6	S7	S8	S3	S4	S1	S2	S4	S1	S2	S3	S2	S3	S4	S1
1400	S4	S1	S2	S3	S2	S3	S4	S1	S8	S5	S6	S7	S5	S6	S7	S8	S7	S8	S5	S6
1430	S8	S5	S6	S7	S6	S7	S8	S5	S4	S1	S2	S3	S1	S2	S3	S4	S3	S4	S1	S2
1500	S2	S3	S4	S1	S4	S1	S2	S3	S6	S7	S8	S5	S7	S8	S5	S6	Make-up; Debrief			
1530	S6	S7	S8	S5	S8	S5	S6	S7	S2	S3	S4	S1	S3	S4	S1	S2				
1600	S3	S4	S1	S2	S1	S2	S3	S4	S7	S8	S5	S6	S8	S5	S6	S7				
1630	S7	S8	S5	S6	S5	S6	S7	S8	S3	S4	S1	S2	S4	S1	S2	S3				

5.5.4 Training

Subjects will be briefed on VIC operation and will receive equipment familiarization prior to the initial experimental test session. Available operations instruction material will be provided for review and study.

5.5.5 Test Sessions

The constraints imposed by number of VICs (4), number of subjects (8), number of experimental conditions (4), and number of trials per condition (variable), help define the number of sessions required for each condition over the test period (4 days). Assuming one session lasts a maximum of approximately 15 minutes (based on the expected time that the number of trials desired will take), each subject will participate in 16 sessions per day (4 hours total). The following Table 5.5.5-1 presents a notional allocation of the total four days' sessions to the experimental conditions for a single subject on a single VIC.

Table 5.5.5-1. Engineering Experiment Data Collection Schedule

Schedule for Single Soldier over Four Day Period (Each Session Repeated 4 Times Per Day - Once per VIC)				
	Monday	**Tuesday**	**Wednesday**	**Thursday**
Session 1 (15 minutes)	Locomotion A	Locomotion B	Locomotion A	Locomotion B
Session 2 (15 minutes)	Locomotion B	Locomotion A	Locomotion B	Locomotion A
Session 3 (15 minutes)	Posture (24 trials)	Search & Engage (24 trials)	Loco Search Inside	Loco Search Outside
Session 4 (15 minutes)	Search & Engage (24 trials)	Posture (24 trials)	Loco Search Outside	Loco Search Inside

Notes: Sessions 1 & 2; 3 & 4 performed back-to-back (break for setup)

5.5.6 Data Analysis

Data collected for each of the tasks as described in Section 5 will be logged and summarized using the Simulyzer data logger and Excel software. Analysis of variance procedures appropriate to the experimental design and subject size will be conducted to determine whether differences exist among the measures of performance for the test sessions. ARI will be primarily responsible for analysis of questionnaire data collected during the experiment; LMIS will be primarily responsible for the analysis of PDU data.

6.0 User Exercises (USEX)

The DWN ERT user exercises (USEX) will be conducted during the week following the engineering experiments. The same soldiers that will participate in the engineering experiments will also take part in the USEX. Thus, soldiers should already be familiar with the operation of the VICs and training can focus on using the simulators within the context of a MOUT mission scenario.

As was the case during the previous DWN USEX, the focus of the exercise will be to assess how well each VIC supports individual- and fireteam-level task performance within the defined operational context. The VICs will be supported by DI SAF forces (fireteam and squad), so interaction between virtual and SAF entities will also be assessed.

The following sections define the proposed mission scenario, including a detailed step-by-step script of the baseline fireteam activities (both VIC and SAF), and outline the proposed training and test schedule.

6.1 MOUT Scenario

6.1.1 Organization

The 1st Platoon, Company A, 1-99 Inf (Mech) is organized as follows for this exercise (see Figure 6.1.1-1):

- 1st Squad: 2 SAF Fireteams and a SAF Squad Leader (1st SL)
- 2d Squad: 1 VIC Fireteam (Alpha FT), 1 SAF fireteam (Bravo FT), and a VIC Squad Leader (2d SL)
- Platoon Leader: 1 VIC (1st PL)
- Platoon Sergeant: 1 BFV (1st PS)

The squads are assumed to be equipped with a mix of Land Warrior (LW) and conventional weapons, where the LW equipment consists of weapon-mounted video displayed on the soldier's simulated IHAS. Weapons include the M16, MWS (day capability only), SAW, Sniper Rifle (OPFOR only), and AT8.

6.1.2 Mission

As part of the A Company, 1-99 Inf (Mech) order to seize Objective Eagle (the entire McKenna MOUT site), the 1st Platoon has been given the mission of seizing and securing Building A. 1st Platoon's objective is in Eagle 1 and consists of the South-East portion of McKenna as marked by the main North-South street and the main East-West street (Limit of Advance or LOA), and 2d Platoon is assigned to the West portion of McKenna up to the LOA (Eagle 2). See Figure 6.1.2-1.

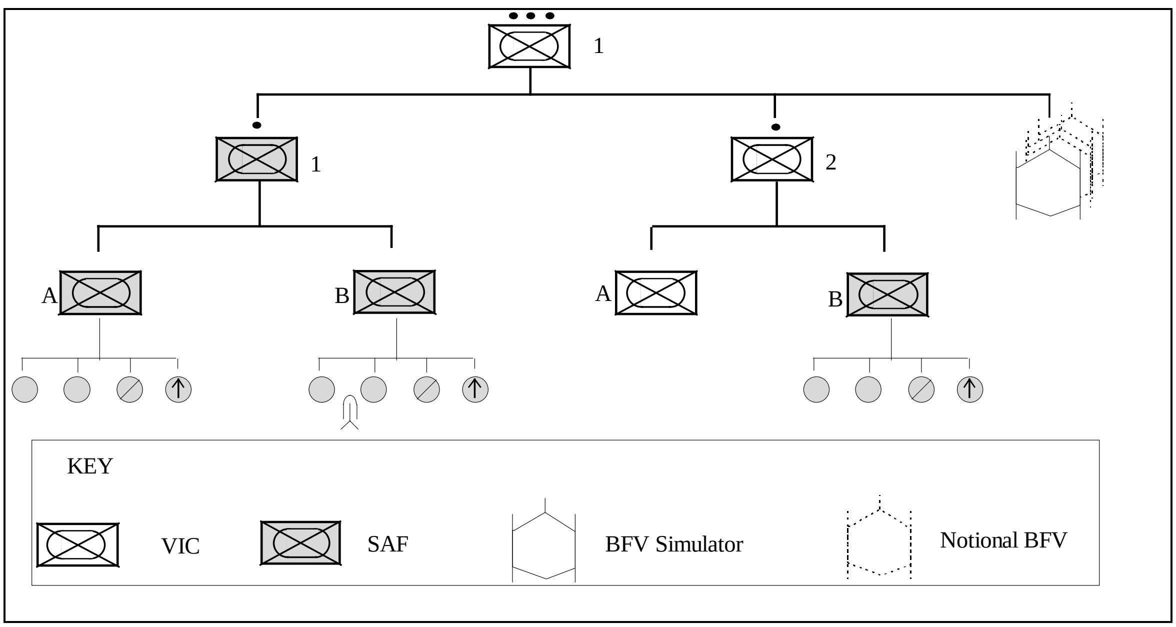


Figure 6.1.1-1 Scenario Organization

Building A is a 2-story row of four brick townhouses linked together. Entry will be made via a hole that will be blown through the southern wall of Building A. Fire support is provided by the Platoon BFVs, which are positioned to the southeast in support position Hawk.

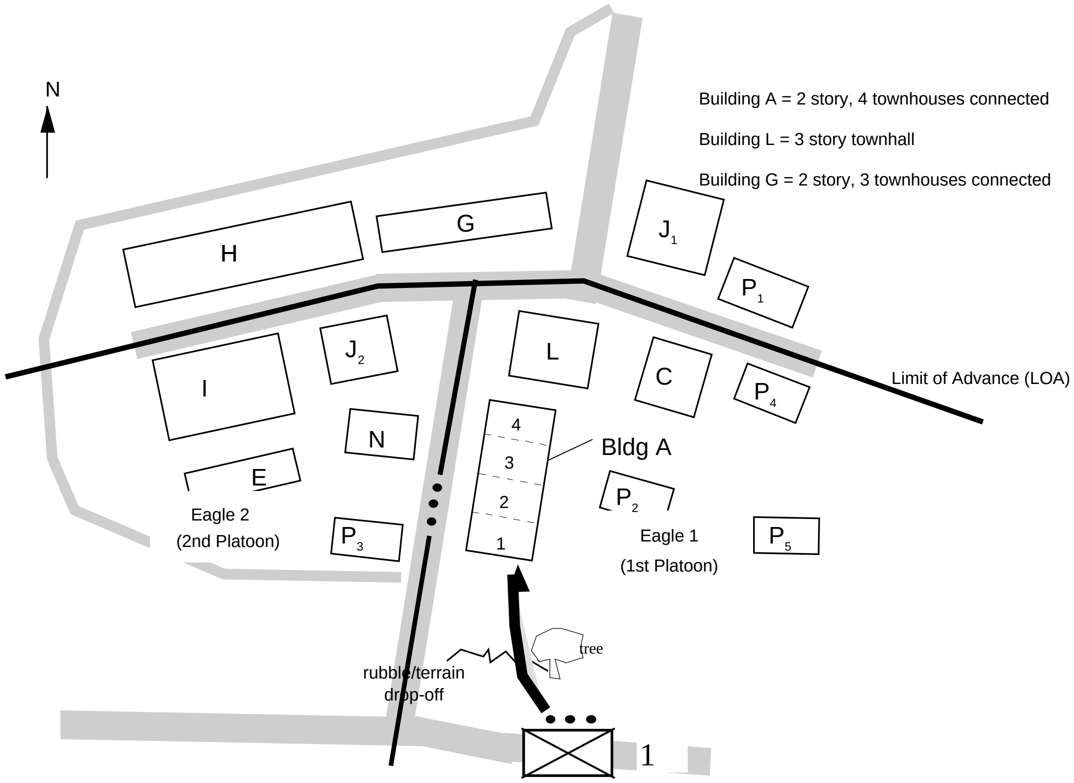


Figure 6.1.2-1: McKenna MOUT Assault Mission

- Enemy: OPFOR strength is projected as a squad (with sniper capability) defending Eagle 1.
- Civilian Population: GRAYFOR (non-combatant) elements have evacuated the urban area.

6.1.3 Concept of Operation

On order, 1st Platoon moves from its AP to seize and secure Building A.

AP to Building A: First and second squads of 1st Platoon take cover and concealed positions in rubble/terrain drop-off near the South end of Building A. 1st Squad creates an entry point for 2d Squad on the South wall of Building A by employing an AT8 from a concealed position behind the tree located on the east side of the drop-off. On order, Alpha FT, 2d Squad, assaults from their positions in the rubble, across the remaining distance to the building and through the opening into the downstairs of the first townhouse and secures the entry room. Bravo FT, 2d Squad and the 1st Squad provide support from positions in the rubble near Building A. When the entry room is secure, the Alpha FTL reports to the 2d SL who moves forward and enters Building A via the same entry point with Bravo FT. Bravo FT then proceeds to clear the next room with Alpha FT providing covering fire.

2d Squad clears all rooms on the first floor and secures the stairwell in the first townhouse as directed by the PL. 2d SL reports rooms secure as the squad clears them. The PL moves with and directs the 1st Squad inside the townhouse. The PL directs 1st Squad to enter the building and move up the staircase to the second floor and to clear rooms on second floor of the townhouse. The second floor of the first two townhouses is connected and 1st Squad continues to clear the second floor for both townhouses. 1st SL reports the second floor secured to the PL. There is no entry point to the second townhouse from the first floor of the first townhouse. The PL directs the 2d Squad to follow the 1st Squad to the second floor, to pass 1st Squad and clear the first floor of the second townhouse from the second floor down. The action continues until the first two townhouses have been cleared in this manner.

The PS controls the fires based on friendly and enemy movements as reported on the radio. The PS tracks the progress of the squads as they move from room to room and reports status to Company as each townhouse is cleared.

Communications: Radio comms are used to communicate maneuver commands during the scenario. Figure 6.1.3.-1 shows the communications networks envisioned for this scenario. VIC to SAF communications will be accomplished by having the SAF operator respond to any SAF fireteam or squad communications. During the experiments, a single radio net was used to facilitate ease of use for the platoon/squad leader role players.

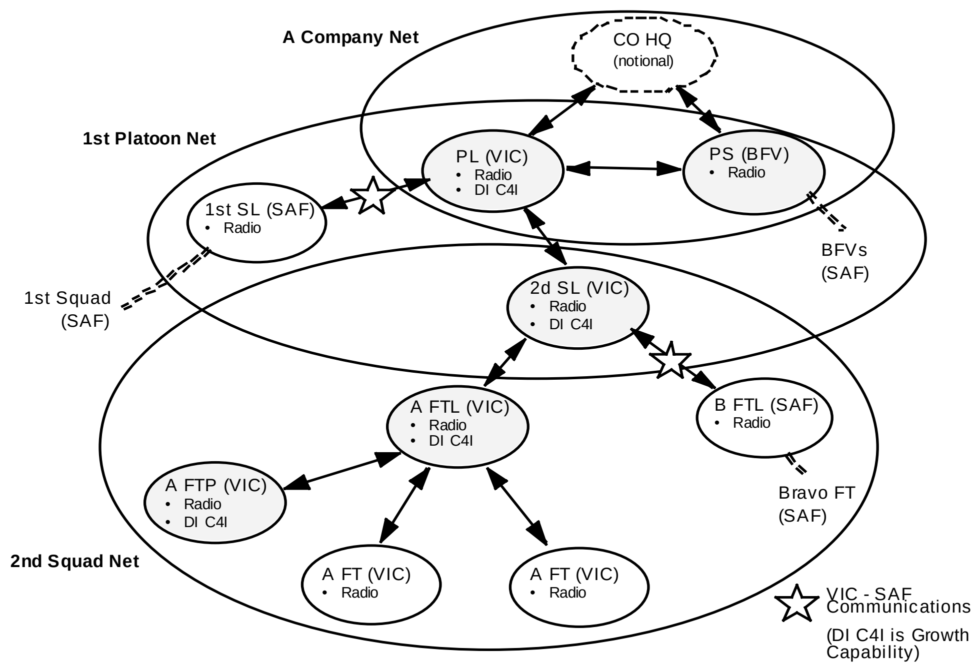
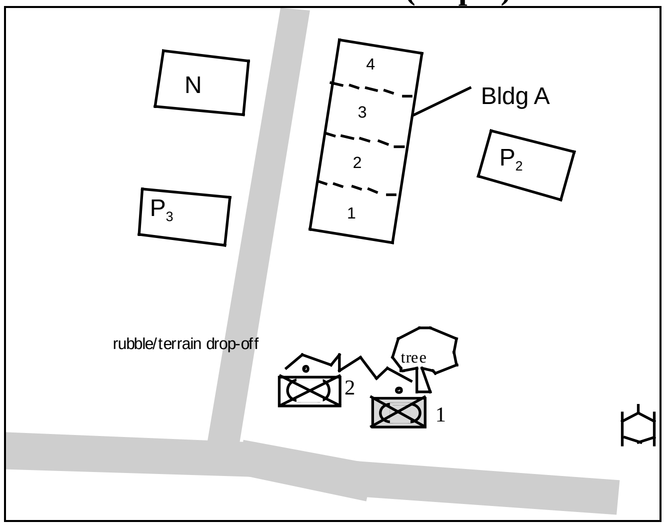


Figure 6.1.3-1: Communications for MOUT Scenario

6.1.4 Step-by-Step Breakdown of Scenario

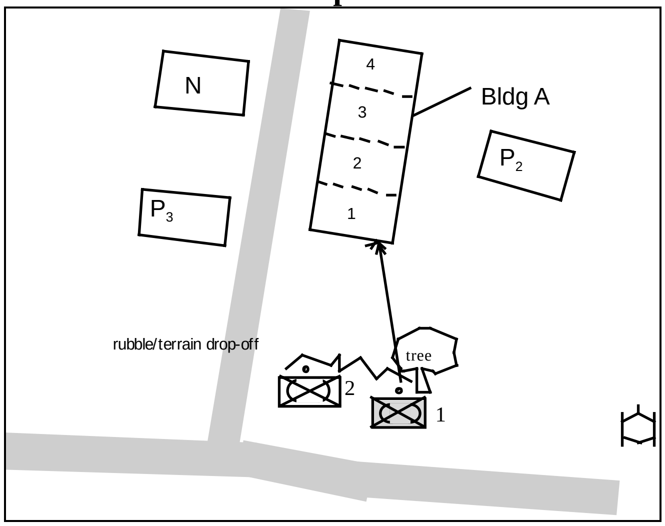
This section provides a detailed breakdown of the mission scenario (vignette) described in the preceding sections. It provides a notional detail of anticipated communications flow and VIC and DI SAF movement through Building A. Each of the following 15 steps defines activity for at most two of the four fireteams.

Initial Conditions (Step 0)



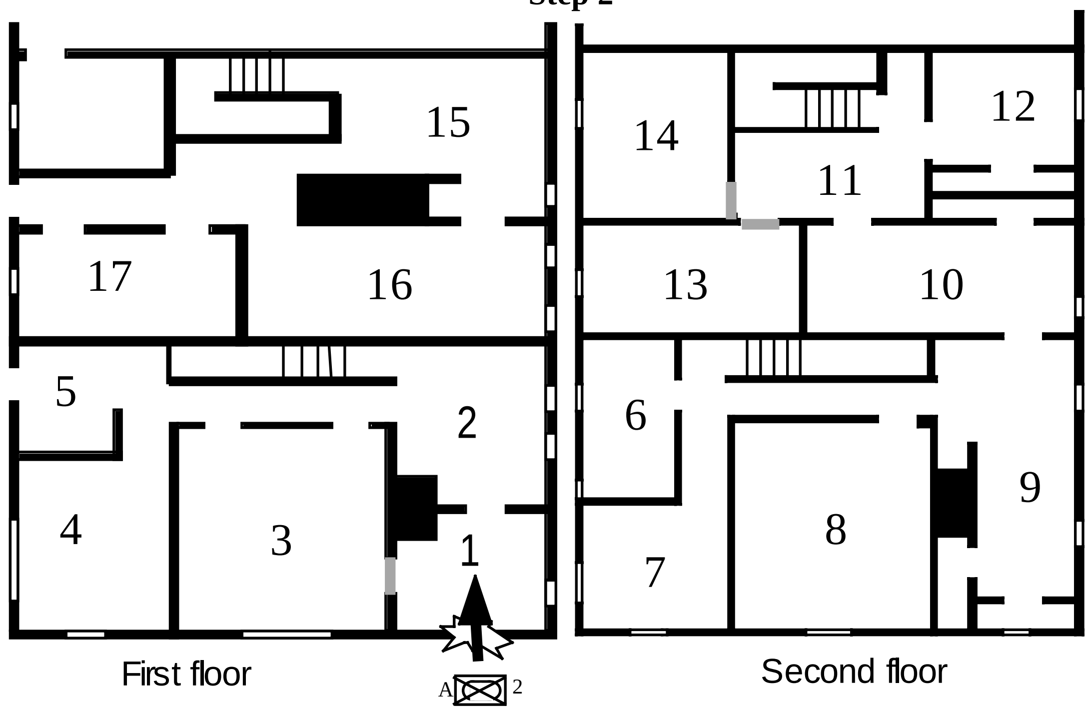
STEP 0	1st Squad		2nd Squad		
Location	**Alpha FT**	**Bravo FT**	**Alpha FT**	**Bravo FT**	**Comments**
Outside	X	X	X	X	Both squads are in the prone position behind the rubble and terrain drop-off to the south of Building A. SAF DI with AT8 is in concealed position behind tree located to the right of rubble. SAF entity has LOS to right side of southern wall of Building A.
Room 1					
Room 2					
Room 3					
Room 4					
Room 5					
Room 6					
Room 7					
Room 8					
Room 9					
Room 10					
Room 11					
Room 12					
Room 13					
Room 14					
Room 15					
Room 16					
Room 17					

Step 1



STEP 1	1st Squad		2nd Squad		
Location	**Alpha FT**	**Bravo FT**	**Alpha FT**	**Bravo FT**	**Comments**
Outside	X	X	X	X	Platoon leader directs 1st Squad LDR to create hole in the RIGHT side of the south wall of Building A with an AT8. 1st Squad LDR directs his AT8 gunner to shoot the AT8 on the right side (1st floor) of Building A. AT8 Gunner fires weapon and blows opening into Room 1.
Room 1					
Room 2					
Room 3					
Room 4					
Room 5					
Room 6					
Room 7					
Room 8					
Room 9					
Room 10					
Room 11					
Room 12					
Room 13					
Room 14					
Room 15					
Room 16					
Room 17					

Step 2



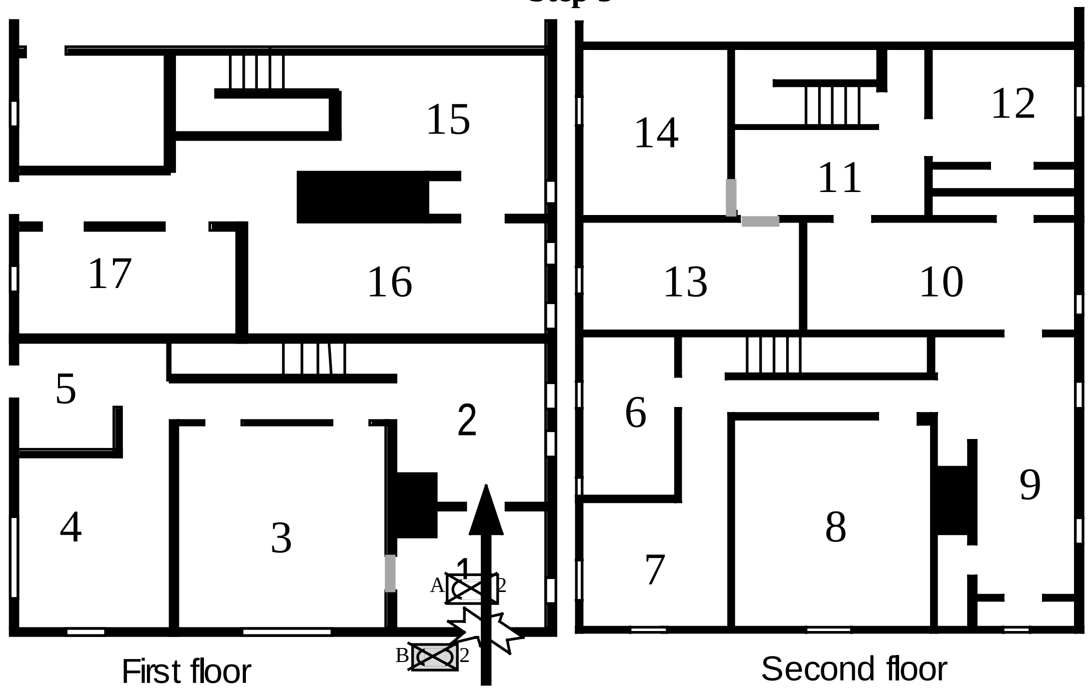
<table>
<tr><td>STEP 2</td><td colspan="2">1st Squad</td><td colspan="2">2nd Squad</td><td></td></tr>
<tr><td>Location</td><td>Alpha FT</td><td>Bravo FT</td><td>Alpha FT</td><td>Bravo FT</td><td>Comments</td></tr>
<tr><td>Outside</td><td>X</td><td>X</td><td></td><td>X</td><td rowspan="17">Platoon LDR directs 2nd Squad LDR to assault through the hole and clear the first floor rooms in Building A.

Platoon LDR directs 1st Squad LDR to provide overwatch.

2nd Squad LDR directs his Alpha FT to move through the hole in Building A and clear Room 1. Report when room is clear.

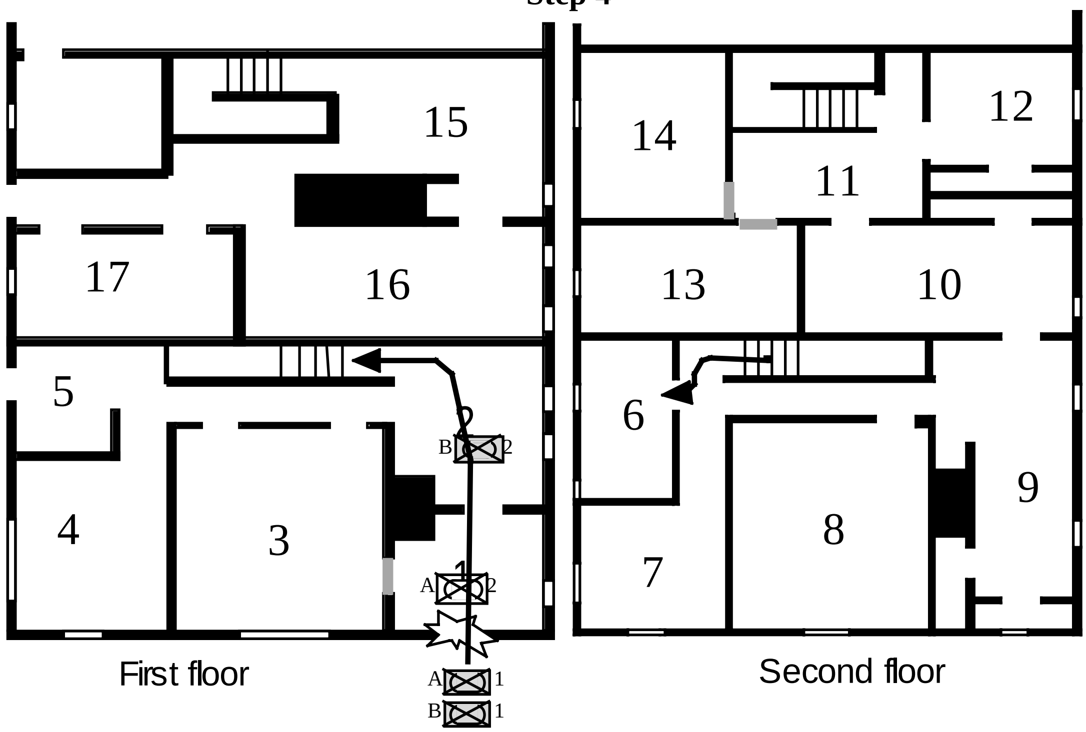
Alpha FT LDR directs his FT to move out and move through the hole and clear the room per SOP. When clear, Alpha FT LDR reports entry room is clear/secured to 2nd Squad LDR. 2nd Squad LDR reports room clear/secured to Platoon LDR.</td></tr>
<tr><td>Room 1</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td>Room 2</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 3</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 4</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 5</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 6</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 7</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 8</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 9</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 10</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 11</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 12</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 13</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 14</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 15</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 16</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Room 17</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Step 3



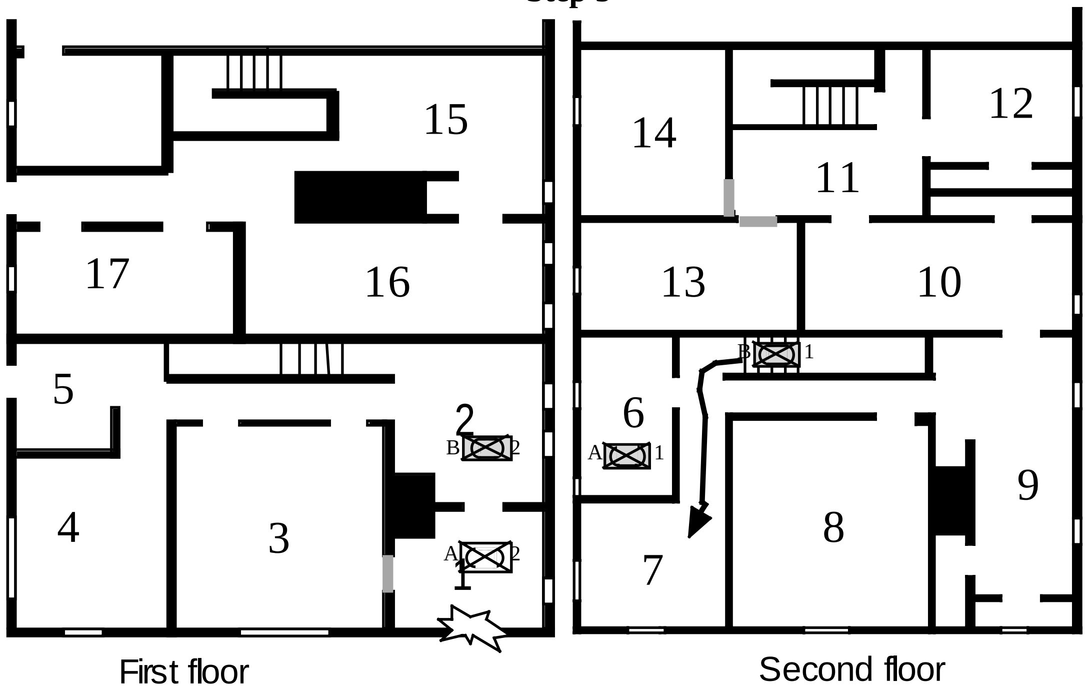
STEP 3	1st Squad		2nd Squad		
Location	**Alpha FT**	**Bravo FT**	**Alpha FT**	**Bravo FT**	**Comments**
Outside	X	X			2nd Squad LDR directs Bravo FT to move through hole and secure Room 2.
Room 1			X		
Room 2				X	
Room 3					Bravo FT LDR directs his FT to move out, move through hole and pass Alpha FT in Room 1 and secure Room 2.
Room 4					
Room 5					
Room 6					2nd Squad LDR follows Bravo FT into building.
Room 7					
Room 8					
Room 9					Bravo FT LDR reports to 2nd Squad LDR that Room 2 and staircase secured.
Room 10					
Room 11					Bravo FT takes up positions once room is secure.
Room 12					
Room 13					
Room 14					2nd Squad LDR reports to Platoon LDR Room 2 and staircase secured.
Room 15					
Room 16					
Room 17					Platoon LDR follows 2nd Squad LDR into building.

Step 4



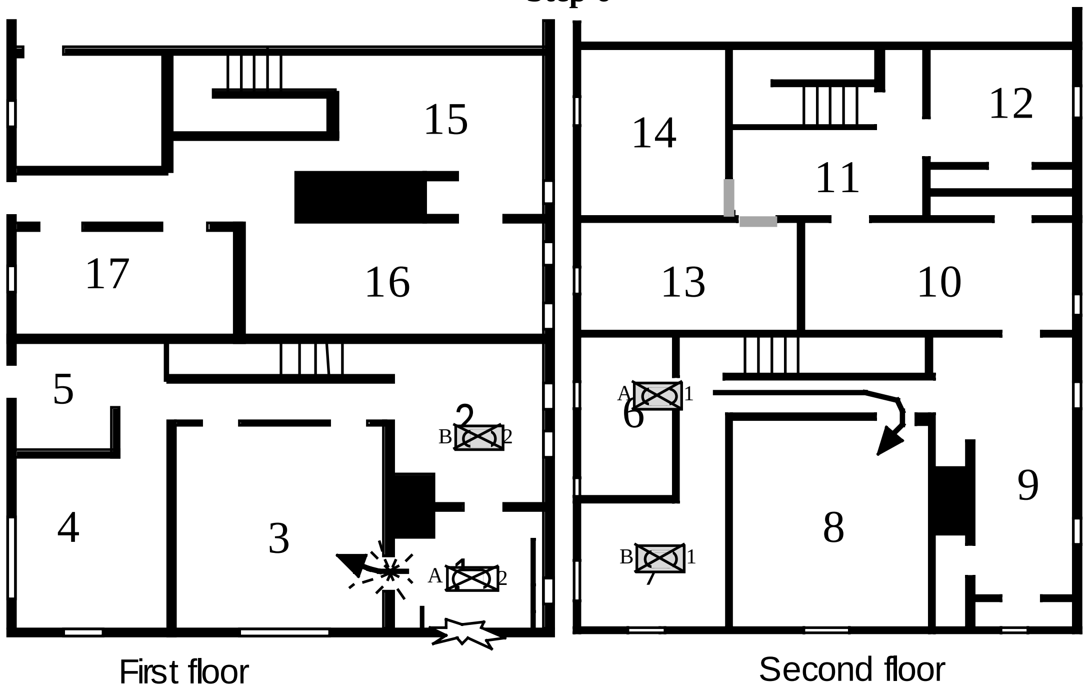
STEP 4	1st Squad		2nd Squad		
Location	**Alpha FT**	**Bravo FT**	**Alpha FT**	**Bravo FT**	**Comments**
Outside		X			Platoon LDR directs 1st Squad LDR to
Room 1			X		move through hole, pass through 2nd
Room 2				X	Squad, move upstairs and clear 2nd floor
Room 3					rooms.
Room 4					
Room 5					1st Squad LDR directs Alpha FT LDR
Room 6	X				to move through hole, pass through 2nd
Room 7					Squad, move upstairs using stairwell and
Room 8					clear Room 6 upstairs per SOP. Bravo
Room 9					FT provides overwatch.
Room 10					
Room 11					Alpha FT LDR directs his FT to move
Room 12					through hole, pass through 2nd Squad,
Room 13					move upstairs using stairwell and clear
Room 14					Room 6 upstairs per SOP.
Room 15					
Room 16					Alpha FT LDR reports Room 6 secure.
Room 17					Alpha FT takes up positions in Room 6.

Step 5



STEP 5	1st Squad		2nd Squad		
Location	**Alpha FT**	**Bravo FT**	**Alpha FT**	**Bravo FT**	**Comments**
Outside					1st Squad LDR directs Bravo FT LDR to move through hole, pass through 2nd Squad, move upstairs, pass through Alpha FT and clear Room 7. Bravo FT LDR directs his FT to move through hole, pass through 2nd Squad, move upstairs using stairwell, pass through Alpha FT, and clear Room 7 upstairs per SOP. 1st Squad LDR follows Bravo FT into building. Bravo FT LDR reports Room 7 secure. Bravo FT takes up positions in Room 7.
Room 1			X		
Room 2				X	
Room 3					
Room 4					
Room 5					
Room 6	X				
Room 7		X			
Room 8					
Room 9					
Room 10					
Room 11					
Room 12					
Room 13					
Room 14					
Room 15					
Room 16					
Room 17					

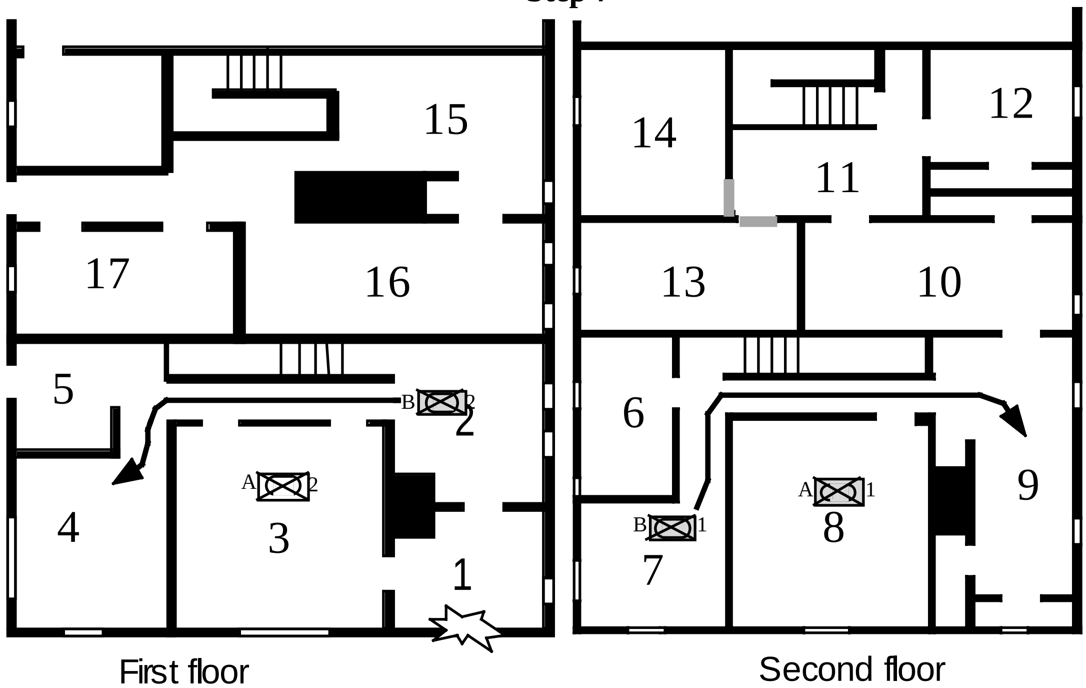
Step 6



STEP 6	1st Squad		2nd Squad		
Location	Alpha FT	Bravo FT	Alpha FT	Bravo FT	Comments
Outside					Once 1st Squad is upstairs, 1st floor clearing operations resume for 2nd Squad. 2nd floor clearing operations can continue simultaneously.
Room 1					
Room 2				X	
Room 3			X		
Room 4					
Room 5					2nd Squad LDR directs Alpha FT LDR to clear Room 3.
Room 6					
Room 7		X			
Room 8	X				Alpha FT LDR directs his FT to breach door to Room 3 using the SAW and enter Room 3 and clear Room 3 per SOP.
Room 9					
Room 10					
Room 11					
Room 12					
Room 13					Alpha FT LDR reports Room 3 secure. Alpha FT takes up positions in Room 3.
Room 14					
Room 15					
Room 16					1st Squad LDR directs Alpha FT LDR to clear Room 8.
Room 17					
					Alpha FT LDR directs his FT to enter Room 8 and clear per SOP.
					Alpha FT LDR reports Room 8 secure.

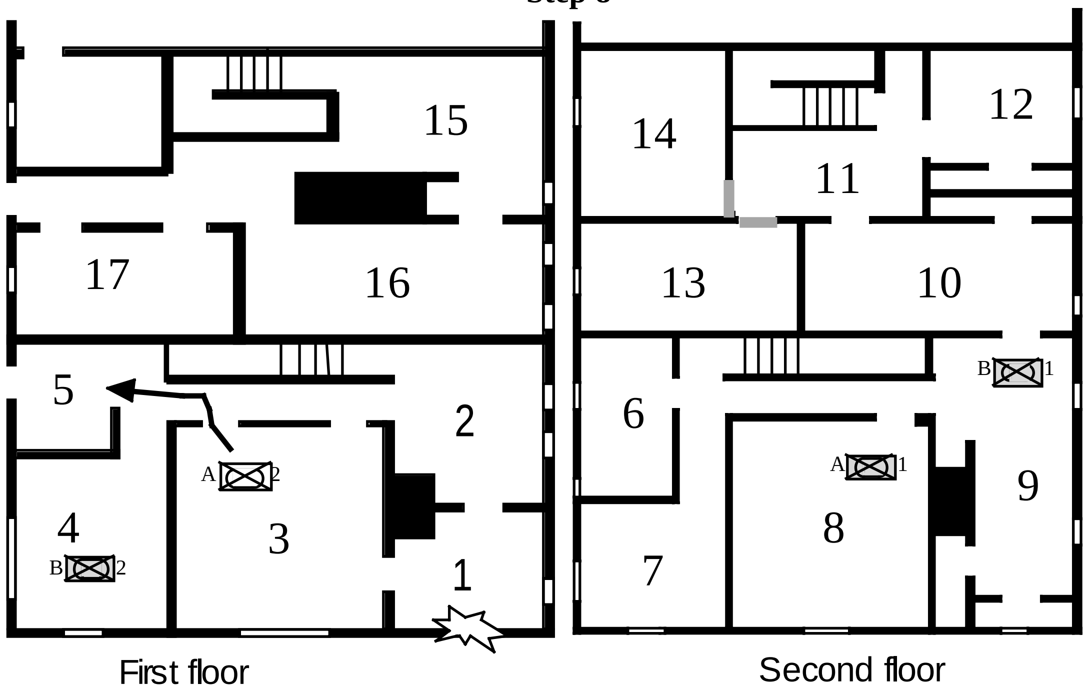
	Alpha FT takes up positions in Room 8.

Step 7



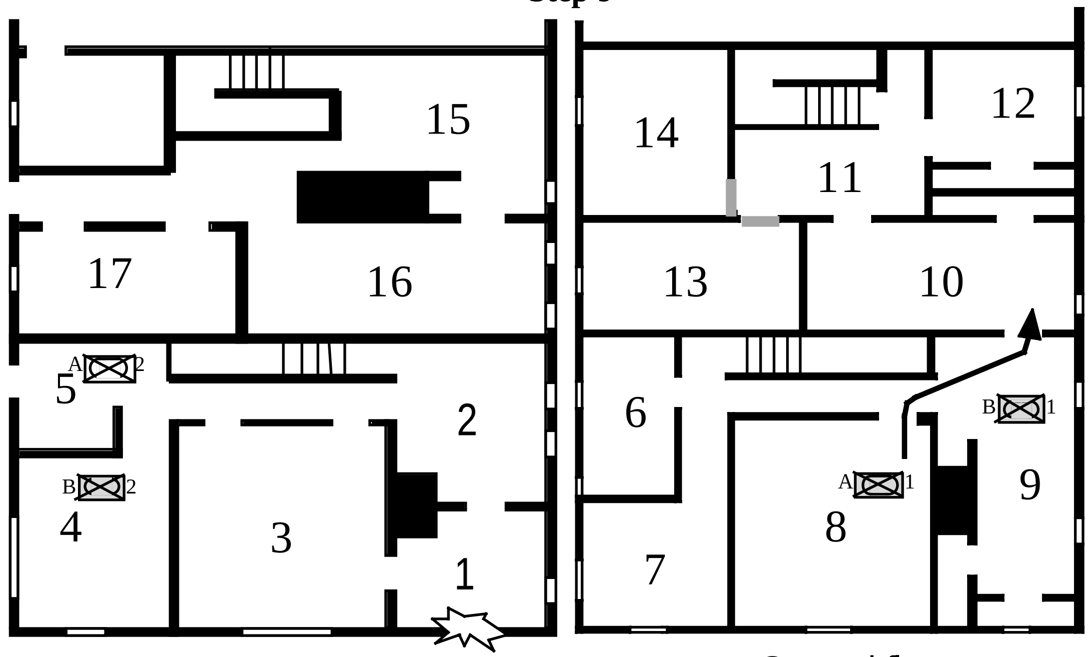
STEP 7	1st Squad		2nd Squad		
Location	**Alpha FT**	**Bravo FT**	**Alpha FT**	**Bravo FT**	**Comments**
Outside					2nd Squad LDR directs Bravo FT LDR
Room 1					to clear Room 4.
Room 2					
Room 3			X		Bravo FT LDR directs his FT to enter
Room 4				X	Room 4 and clear per SOP.
Room 5					
Room 6					Bravo FT LDR reports Room 4 secure.
Room 7					Bravo FT takes up positions in Room 4.
Room 8	X				
Room 9		X			1st Squad LDR directs Bravo FT LDR
Room 10					to clear Room 9.
Room 11					
Room 12					Bravo FT LDR directs his FT to enter
Room 13					Room 9 and clear per SOP.
Room 14					
Room 15					Bravo FT LDR reports Room 9 secure.
Room 16					Bravo FT takes up positions in Room 9.
Room 17					

Step 8



STEP 8	1st Squad		2nd Squad		
Location	**Alpha FT**	**Bravo FT**	**Alpha FT**	**Bravo FT**	**Comments**
Outside					2nd Squad LDR directs Alpha FT LDR
Room 1					to clear Room 5.
Room 2					
Room 3					Alpha FT LDR directs his FT to enter
Room 4				X	Room 5 and clear per SOP.
Room 5			X		
Room 6					Alpha FT LDR reports Room 5 secure.
Room 7					Alpha FT takes up positions in Room 5.
Room 8	X				
Room 9		X			
Room 10					
Room 11					
Room 12					
Room 13					
Room 14					
Room 15					
Room 16					
Room 17					

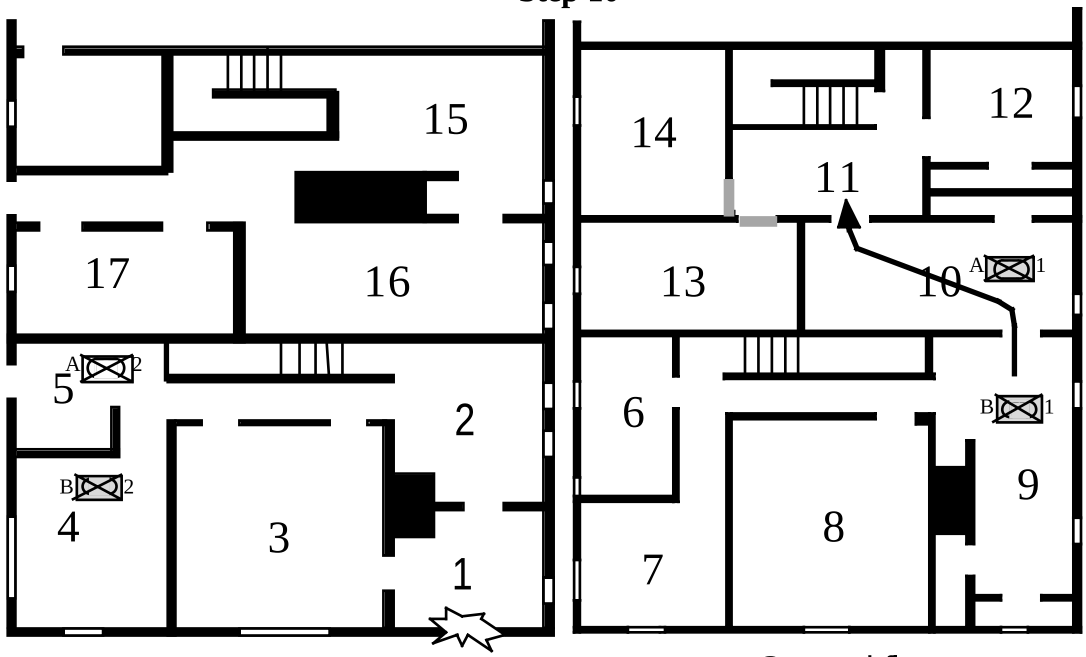
Step 9



First floor Second floor

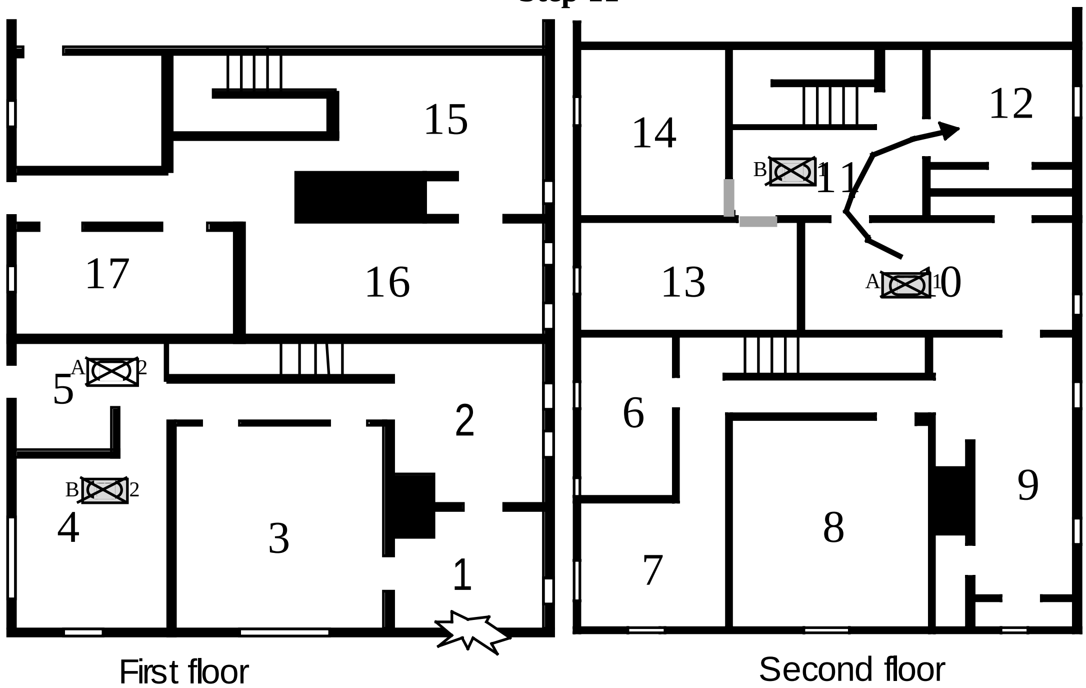
STEP 9	1st Squad		2nd Squad		
Location	**Alpha FT**	**Bravo FT**	**Alpha FT**	**Bravo FT**	**Comments**
Outside					1st Squad LDR directs Alpha FT LDR to clear Room 10. Alpha FT LDR directs his FT to enter Room 10 and clear per SOP. Alpha FT LDR reports Room 10 secure. Alpha FT takes up positions in Room 10.
Room 1					
Room 2					
Room 3					
Room 4				X	
Room 5			X		
Room 6					
Room 7					
Room 8					
Room 9		X			
Room 10	X				
Room 11					
Room 12					
Room 13					
Room 14					
Room 15					
Room 16					
Room 17					

Step 10



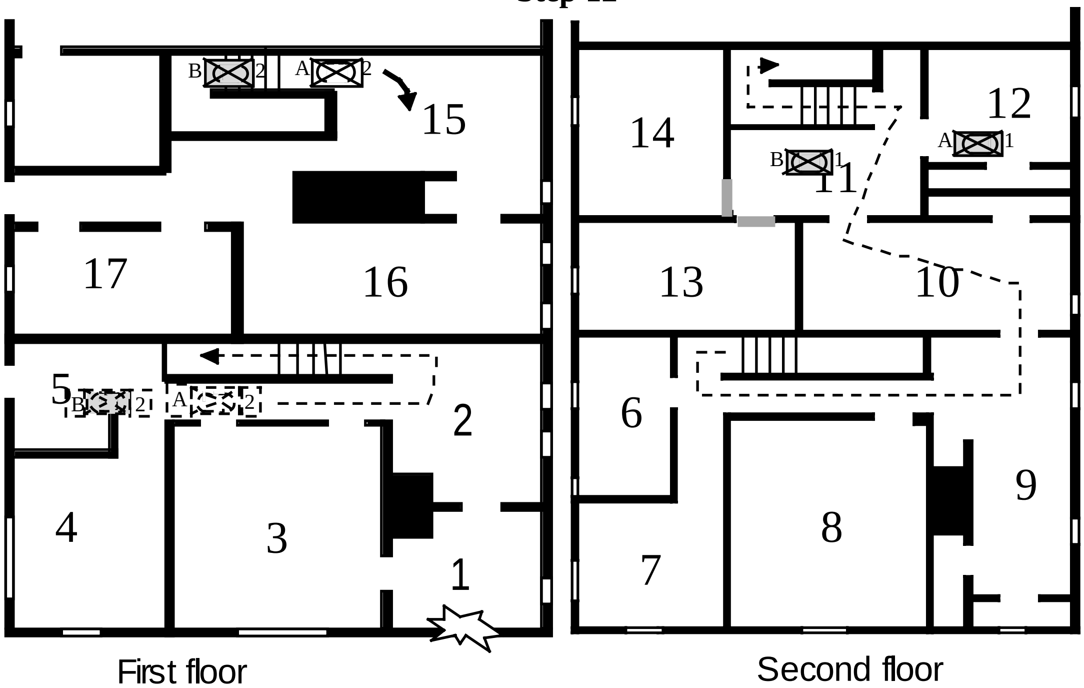
STEP 10	1st Squad		2nd Squad		
Location	**Alpha FT**	**Bravo FT**	**Alpha FT**	**Bravo FT**	**Comments**
Outside					1st Squad LDR directs Bravo FT LDR to pass through Alpha FT and clear Room 11.
Room 1					
Room 2					
Room 3					
Room 4				X	Bravo FT LDR directs his FT to pass through Alpha FT and enter Room 11 and clear per SOP.
Room 5			X		
Room 6					
Room 7					
Room 8					Bravo FT LDR reports Room 11 and top part of stairwell secure.
Room 9					
Room 10	X				
Room 11		X			Bravo FT takes up positions in Room 11.
Room 12					
Room 13					
Room 14					Platoon LDR directs 2nd Squad LDR to bring his squad upstairs, through Rooms 10 and 11, and downstairs to begin clearing 1st floor of 2nd townhouse.
Room 15					
Room 16					
Room 17					

Step 11



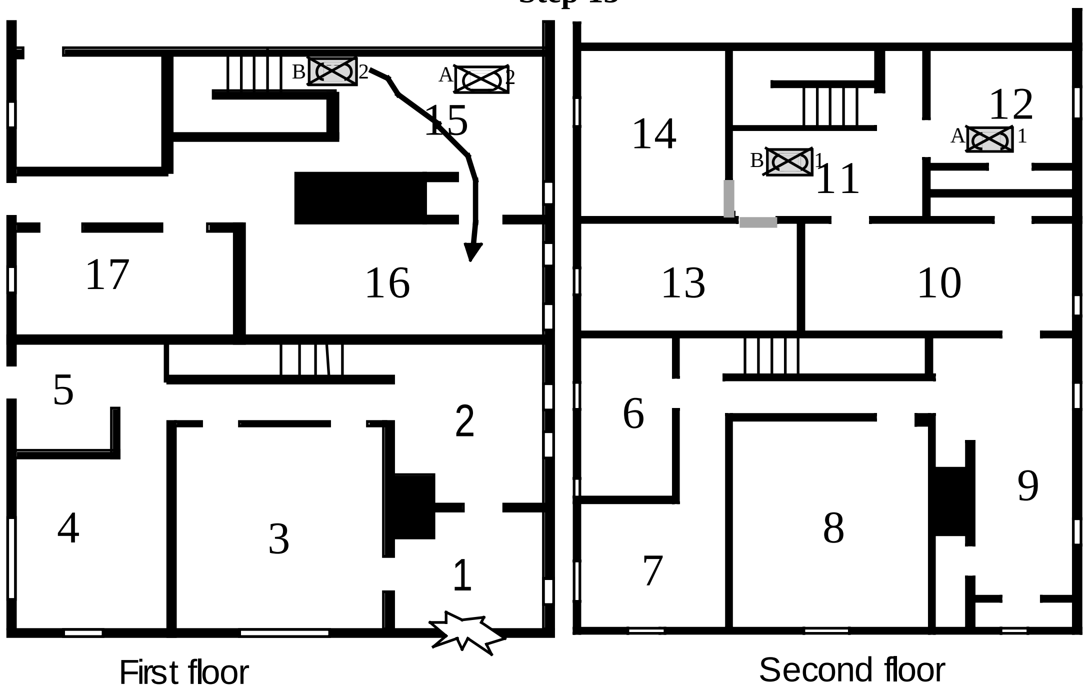
STEP 11	1st Squad		2nd Squad		
Location	**Alpha FT**	**Bravo FT**	**Alpha FT**	**Bravo FT**	**Comments**
Outside					1st Squad LDR directs Alpha FT LDR to pass through Bravo FT and clear Room 12.
Room 1					
Room 2					
Room 3					
Room 4				X	Alpha FT LDR directs his FT to pass through Bravo FT and enter Room 12 and clear per SOP.
Room 5			X		
Room 6					
Room 7					
Room 8					Alpha FT LDR reports Room 12 secure.
Room 9					
Room 10					Alpha FT takes up positions in Room 12.
Room 11		X			
Room 12	X				
Room 13					
Room 14					
Room 15					
Room 16					
Room 17					

Step 12



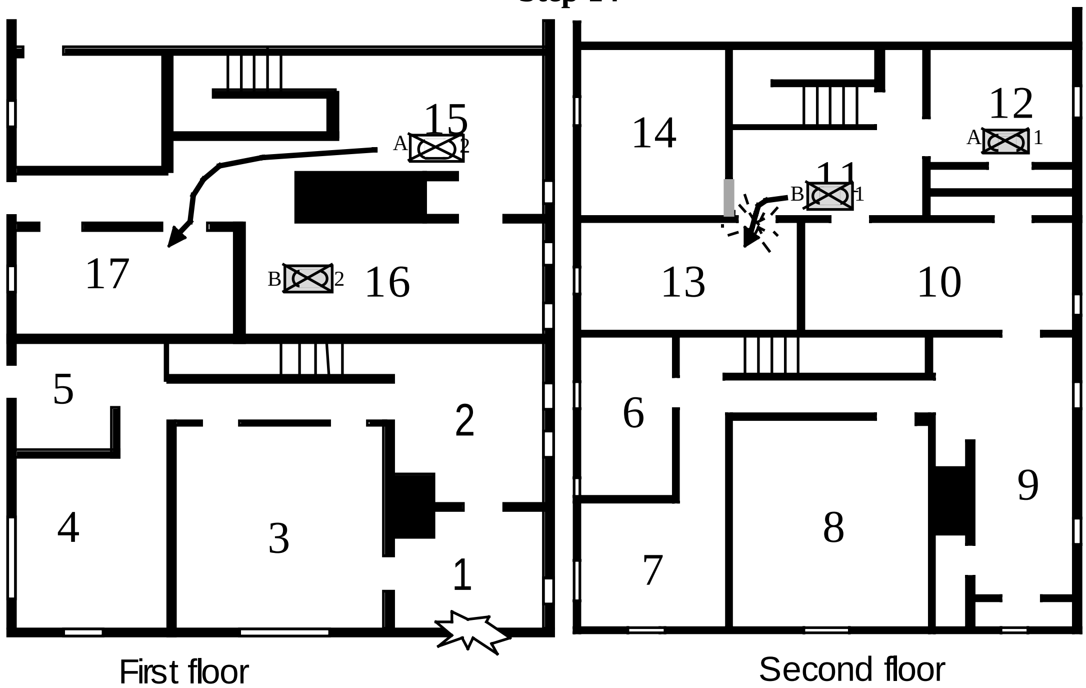
STEP 12	1st Squad		2nd Squad		
Location	**Alpha FT**	**Bravo FT**	**Alpha FT**	**Bravo FT**	**Comments**
Outside					2nd Squad LDR directs Alpha and Bravo FT LDRs to move teams up stairs, through Room 10 and into 11. Directs Alpha FT to continue through 11 and to go downstairs and clear Room 15. Alpha FT LDR directs his team to go upstairs, pass through Bravo FT (1st Squad) who is in Room 11, and to go down stairwell and to enter Room 15 and clear per SOP. Bravo FT LDR (2nd Squad) directs his team upstairs, pass through Bravo FT (1st Squad) who is in Room 11, and to enter stairwell and hold until Alpha FT LDR reports Room 15 secure. Alpha FT LDR reports Room 15 secure. Alpha FT takes up positions in Room 15.
Room 1					
Room 2					
Room 3					
Room 4					
Room 5					
Room 6					
Room 7					
Room 8					
Room 9					
Room 10					
Room 11		X		Stairway	
Room 12	X				
Room 13					
Room 14					
Room 15			X		
Room 16					
Room 17					

Step 13



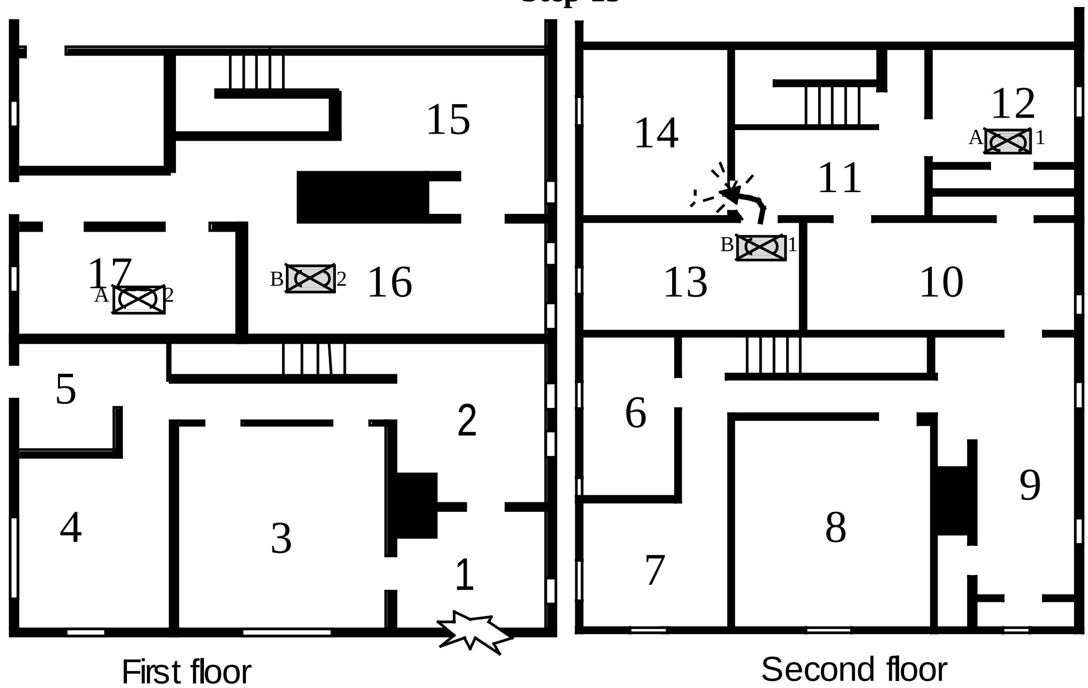
STEP 13	1st Squad		2nd Squad		
Location	**Alpha FT**	**Bravo FT**	**Alpha FT**	**Bravo FT**	**Comments**
Outside					Bravo FT LDR directs his team to continue downstairs, pass through Alpha FT in Room 15, and to enter Room 16 and clear per SOP. Bravo FT LDR reports Room 16 secure. Bravo FT takes up positions in Room 16.
Room 1					
Room 2					
Room 3					
Room 4					
Room 5					
Room 6					
Room 7					
Room 8					
Room 9					
Room 10					
Room 11		X			
Room 12	X				
Room 13					
Room 14					
Room 15			X		
Room 16				X	
Room 17					

Step 14



STEP 14	1st Squad		2nd Squad		
Location	**Alpha FT**	**Bravo FT**	**Alpha FT**	**Bravo FT**	**Comments**
Outside					Alpha FT LDR directs his team to enter Room 17 and clear per SOP. Alpha FT LDR reports Room 17 secure. Alpha FT takes up positions in Room 17. Bravo FT LDR directs his FT to enter Room 13 and clear per SOP. Must breach door with SAW. Bravo FT LDR reports Room 13 secure. Bravo FT takes up positions in Room 13.
Room 1					
Room 2					
Room 3					
Room 4					
Room 5					
Room 6					
Room 7					
Room 8					
Room 9					
Room 10					
Room 11					
Room 12	X				
Room 13		X			
Room 14					
Room 15					
Room 16				X	
Room 17			X		

Step 15



STEP 15	1st Squad		2nd Squad		
Location	**Alpha FT**	**Bravo FT**	**Alpha FT**	**Bravo FT**	**Comments**
Outside					Bravo FT LDR directs his FT to enter Room 14 and clear per SOP. Must breach door with SAW. Bravo FT LDR reports Room 14 secure. Bravo FT takes up positions in Room 14. ENDEX
Room 1					
Room 2					
Room 3					
Room 4					
Room 5					
Room 6					
Room 7					
Room 8					
Room 9					
Room 10					
Room 11					
Room 12	X				
Room 13					
Room 14		X			
Room 15					
Room 16				X	
Room 17			X		

6.2 USEX Schedule and Design

Table 6.2-1 below highlights the USEX portion of the DWN ERT experiment schedule. The soldiers will be familiar with the operation of the VICs following the engineering experiments, so training will focus on using the simulators in a tactically appropriate manner as dictated by the exercise scenario.

Table 6.2-1 USEX Schedule

DWN ERT Experiment Schedule July 1998						
Sunday	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**
5	6 Soldier Training	7	8 Pre-Experiment Integration	9	10	11
12	13 Engineering Experiments Data Collection	14	15	16 Live Tests (McKenna)	17 Data Collection	18
19	20 USEX Training and Data Collection	21	22	23 Media Day	24 Aiming Tests	25

6.2.1 *Daily Schedule*

<u>Day 1 - Monday 20th</u>

Time	**Alpha**	**Delta**	**Echo**	**Golf**
0800	TL	M1	M2	M3
0900	TL	M1	M2	M3
1000	M3	TL	M1	M2
1100	M3	TL	M1	M2
LUNCH				
1300	M2	M3	TL	M1
1400	M2	M3	TL	M1
1500	M1	M2	M3	TL
1600	M1	M2	M3	TL

Table 6.2.1-1 First Day Schedule

Soldiers will practice fireteam building clearing operations on Building A. Alternate teams of soldiers will practice allowing the ‘off’ team to observe and rest. Squad and platoon leader role-players will support this training. Each soldier will fill a specific role on the fireteam, and this role will be practiced on each of the four VICs. Thus, each soldier will practice once on each VIC. This will allow determination of whether specific VICs are inappropriate to fill a specific role on the fireteam, so actual data collection trials can be conducted on systems where the most useful data can be gathered.

During this time, SAF operators can be either generating performance comparison data (see Section 7) or practicing Building A clearing operations and/or SAF fireteam/squad coordination.

Days 2 and 3 - Tuesday 21st and Wednesday 22nd

These two days will provide the bulk of the data collection effort. Each session is scheduled for one hour, which includes the execution of the scenario vignette and AAR.

Session	Alpha	Delta	Echo	Golf
1	S8	S5	S6	S7
2	S3	S4	S1	S2
3	S7	S8	S5	S6
4	S2	S3	S4	S1

Table 6.2.1-2 Day 2 Schedule

Session	Alpha	Delta	Echo	Golf
5	S6	S7	S8	S5
6	S1	S2	S3	S4
7	S5	S6	S7	S8
8	S4	S1	S2	S3

Table 6.2.1-3 Day 3 Schedule

For these eight data collection runs, the soldiers began with the execution of the basic scenario. It was discovered during the practice sessions that the scenario was self-modifying based on which SAF fireteam was killed by the sniper. Since the sniper was positioned in different rooms for different runs, different SAF fireteams would be put out of commission by the sniper (the SAF were invariably killed by the manned sniper). This would cause the scenario to be altered to have the VIC fireteam compensate for the missing fireteam. The net effect was that the scenario was never the same for the soldiers from one run to another.

Day 4 - Thursday 23rd

Media Day. Assume no data collection during this period.

Day 5 - Friday 24th

USEX data collection had been completed. The available time was used to collect VIC Delta aiming data to support possible improvements for this capability, as well as to complete soldier debrief and questionnaire completion.

6.2.2 Data Collection

Data to be collected include the same PDU data collected during the engineering experiments, including logger files, as well as subjective questionnaire data, the form and substance of which is to be determined by Orlando and Ft. Benning branches of ARI.

7.0 DI SAF Performance Assessments

Since there have been significant enhancements to the DI SAF over its capabilities during the previous DWN experiments, an object of the DWN ERT tests is to assess how well the DI SAF perform as compared to soldiers in the virtual simulators and in live McKenna MOUT task execution. To this end, the DI SAF will be asked to perform the same engineering experiment tasks that the soldiers will be asked to perform. They already will be performing the same tasks as the VICs during the USEX.

One issue that complicates direct SAF - live performance comparison is that the actual McKenna MOUT site building in which the SAF can operate (Building A) is full of furniture of various types. This furniture can be replicated in the virtual Building A, but the SAF does not have a mechanism to perceive or react to the presence of furniture. Thus, live behavior will be constrained or influenced by the presence of this furniture whereas the SAF will not. In an attempt to permit SAF - live comparisons, albeit indirectly, we intended to conduct locomotion and locomotion and search trials both with and without the furniture models in the virtual Building A. Thus, VIC - SAF comparisons could be made for those trials without furniture, and VIC - live comparisons could be on those trials conducted with furniture. Given consistent performance, some inferences should be able to be made about SAF - live performance correlation. However, the limited time available did not permit the verification of furniture locations and implementation of new furniture files for the VICs. Thus, all locomotion trials were conducted with no furniture in place.

Plans to conduct the virtual USEX trials in Building A without furniture we implemented without change. Since the SAF will ignore the furniture, it may be disconcerting to the soldiers in the VICs to observe their SAF counterparts walking through furniture where they cannot.

8.0 Live Data Validation Tests at McKenna MOUT Site

On the Thursday of the engineering week, one-half day (morning) was spent at the actual McKenna MOUT site in Building A. Multiple locomotion runs will be conducted to allow practice and permit the development of averaged performance measures. It is hoped that instrumentation data can be collected to support our analysis efforts. However, only the southern-most townhouse was instrumented, so it was not possible to collect data over the entire locomotion route, so no instrumentation data was collected.

Also, the soldiers (one squad) will simulate the USEX scenario while at the MOUT site. This is intended to help determine if any benefit of this experience is carried over to the virtual environment.

9.0 Appendix – Engineering Experiment Trial Definition

9.1 Visual Search and Engagement Trials

		Relative Azimuth Offset			
Range (meters)	**Speed (mph)**	**80°**	**130°**	**230°**	**315°**
50	**0**	1	2	3	4
	4	5	6	7	8
	8	9	10	11	12
100	**0**	13	14	15	16
	4	17	18	19	20
	8	21	22	23	24
150	**0**	25	26	27	28
	4	29	30	31	32
	8	33	34	35	36
25	**0**	37	38	39	40
	4	41	42	43	44
	8	45	46	47	48

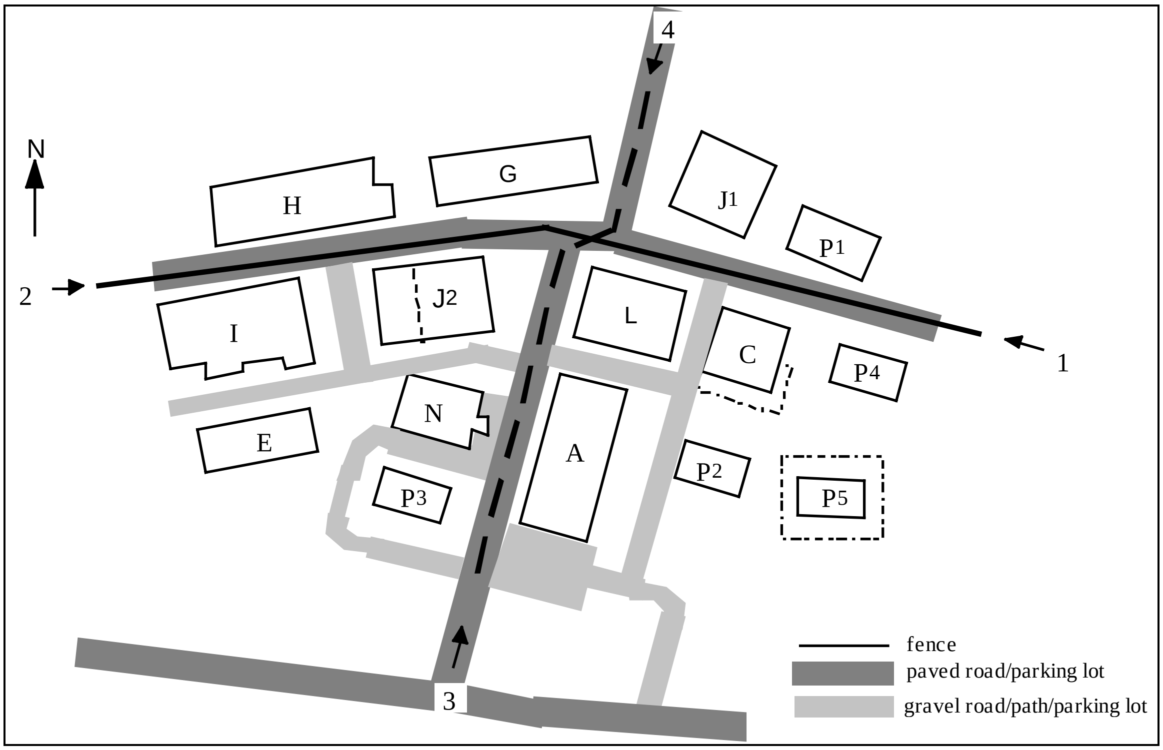
This matrix defines the 48 trials to be run for this task. Four randomizations of these 48 trials will be used to ensure target appearance order will not be learned by the soldiers. The first 24 trials (‘A’ group) of each group will be presented to the soldiers over the first (morning) exposure to the VICs. The second 24 trials (‘B’ group) of each group will be presented to the soldiers in their second (afternoon) exposure to the VICs. The scheduling of this task can be seen in the Monday, July 13th schedule.

9.2 Weapon Aiming Posture Trials

		Relative Azimuth Offset			
Range (meters)	**Posture**	**10°**	**20°**	**345°**	**355°**
50	**Standing**	1	2	3	4
	Kneeling	5	6	7	8
	Prone	9	10	11	12
100	**Standing**	13	14	15	16
	Kneeling	17	18	19	20
	Prone	21	22	23	24
150	**Standing**	25	26	27	28
	Kneeling	29	30	31	32
	Prone	33	34	35	36
25	**Standing**	37	38	39	40
	Kneeling	41	42	43	44
	Prone	45	46	47	48

This matrix defines the 48 trials to be run for this task. Four randomizations of these 48 trials will be used to ensure target appearance order will not be learned by the soldiers. The first 24 trials ('A' group) of each group will be presented to the soldiers over the first (morning) exposure to the VICs. The second 24 trials ('B' group) of each group will be presented to the soldiers in their second (afternoon) exposure to the VICs. The trial randomization has been conditioned so that the standing, kneeling, and prone trials presented in each session are grouped by posture so that the soldier gets, for example, 8 standing, 6 kneeling, and 10 prone. This is done to minimize posture changes between trials. The scheduling of this task can be seen in the Tuesday, July 14th schedule.

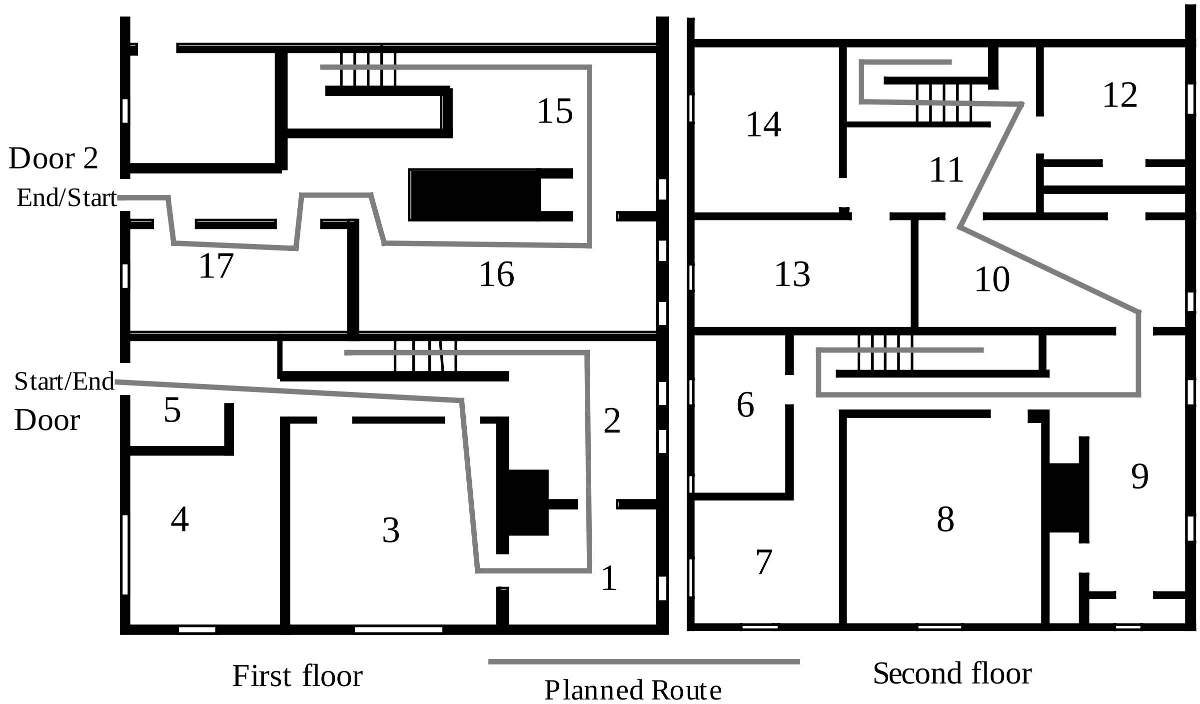
9.3 Locomotion and Search Trials



1. Outside Search. The above figure shows the routes defined for this task. Two basic paths - one north-south and the other east-west - provide four routes by defining starting points at either end. These four routes each will have two different target layouts (A and B) for a total of eight different conditions, the number required for two exposures of the four VICs per soldier. The scheduling of this task can be seen in the Wednesday, July 15th schedule.

2. Inside Search. Soldiers will be instructed to completely search the two target townhouses in Building A for DI targets and shoot them when located. No route will be specified. Eight different target layouts will be used to eliminate the possibility of the soldiers memorizing target locations. Soldiers will start from either Door 1 or 2 (four of each) when beginning the search to offer a variety of target placement options. The scheduling of this task can be seen in the Thursday, July 16th schedule.

9.4 Locomotion Trials



The above figure shows the planned locomotion route through the first two townhouses in Building A. The route is intended to pass through hallways, stairways, and to include some maneuvering through doorways to make it somewhat challenging. Soldiers will alternate starting locations (Door 1 or 2) for some minimal variety (the 'A' and 'B' routes in the schedule). Keeping the same route should facilitate learning, so that terminal performance should be a function of system characteristics more than familiarity with the route. The scheduling of this task can be seen in the Monday through Thursday schedules.

9.5 Subject-Trial Allocation

The following pages identify the daily subject-trial session pairings for the engineering experiments. Times originally presented are deleted in favor of session numbers. The initial schedule developed was modified on a daily basis to reflect changes made due to lessons learned and the realities of soldier performance on the VICs. The schedule presented here reflects the actual trials conducted. Trial orderings within each session were developed prior to integration.

Monday, July 13th

	VIC							
Session	Alpha		Delta		Echo		Golf	
	Soldier Training							
1	S1	Post 3A	S2	Post 4A	S3	Post 1A	S4	Post 2A
2	S1	S&E 1A	S2	S&E 2A	S3	S&E 3A	S4	S&E 4A
3	S5	Post 4A	S6	Post 1A	S7	Post 2A	S8	Post 3A
4	S5	S&E 2A	S6	S&E 3A	S7	S&E 4A	S8	S&E 1A
5	S2	Loco A	S3	Loco B	S4	Loco A	S1	Loco B
6	S2	Loco B	S3	Loco A	S4	Loco B	S1	Loco A
7	S6	Loco B	S7	Loco A	S8	Loco B	S5	Loco A
8	S6	Loco A	S7	Loco B	S8	Loco A	S5	Loco B
9	S3	S&E 1A	S4	S&E 2A	S1	S&E 3A	S2	S&E 4A
10	S3	Post 3A	S4	Post 4A	S1	Post 1A	S2	Post 2A
11	S7	S&E 2A	S8	S&E 3A	S5	S&E 4A	S6	S&E 1A
12	S7	Post 4A	S8	Post 1A	S5	Post 2A	S6	Post 3A
13	S4	Loco A	S1	Loco B	S2	Loco A	S3	Loco B
14	S4	Loco B	S1	Loco A	S2	Loco B	S3	Loco A

Tuesday, July 14th

	VIC							
Session	**Alpha**		**Delta**		**Echo**		**Golf**	
15	S8	Loco B	S5	Loco A	S6	Loco B	S7	Loco A
16	S8	Loco A	S5	Loco B	S6	Loco A	S7	Loco B
17	S2	Post 1A	S3	Post 2A	S4	Post 3A	S1	Post 4A
18	S2	S&E 3A	S3	S&E 4A	S4	S&E 1A	S1	S&E 2A
19	S6	Post 2A	S7	Post 3A	S8	Post 4A	S5	Post 1A
20	S6	S&E 4A	S7	S&E 1A	S8	S&E 2A	S5	S&E 3A
21	S3	Loco A	S4	Loco B	S1	Loco A	S2	Loco B
22	S3	Loco B	S4	Loco A	S1	Loco B	S2	Loco A
23	S7	Loco B	S8	Loco A	S5	Loco B	S6	Loco A
24	S7	Loco A	S8	Loco B	S5	Loco A	S6	Loco B
25	S4	S&E 3A	S1	S&E 4A	S2	S&E 1A	S3	S&E 2A
26	S4	Post 1A	S1	Post 2A	S2	Post 3A	S3	Post 4A
27	S8	S&E 4A	S5	S&E 1A	S6	S&E 2A	S7	S&E 3A
28	S8	Post 2A	S5	Post 3A	S6	Post 4A	S7	Post 1A
29	S1	Loco A	S2	Loco B	S3	Loco A	S4	Loco B
30	S1	Loco B	S2	Loco A	S3	Loco B	S4	Loco A
31	S5	Loco B	S6	Loco A	S7	Loco B	S8	Loco A
32	S5	Loco A	S6	Loco B	S7	Loco A	S8	Loco B
33	S3	Post 3B	S4	Post 4B	S1	Post 1B	S2	Post 2B
34	S3	S&E 1B	S4	S&E 2B	S1	S&E 3B	S2	S&E 4B

Wednesday, July 15th

	VIC							
Session	**Alpha**		**Delta**		**Echo**		**Golf**	
35	S7	Post 4B	S8	Post 1B	S5	Post 2B	S6	Post 3B
36	S7	S&E 2B	S8	S&E 3B	S5	S&E 4B	S6	S&E 1B
37	S1	S&E 1B	S2	S&E 2B	S3	S&E 3B	S4	S&E 4B
38	S1	Post 3B	S2	Post 4B	S3	Post 1B	S4	Post 2B
39	S5	S&E 2B	S6	S&E 3B	S7	S&E 4B	S8	S&E 1B
40	S5	Post 4B	S6	Post 1B	S7	Post 2B	S8	Post 3B
41	S4	Post 1B	S1	Post 2B	S2	Post 3B	S3	Post 4B
42	S4	S&E 3B	S1	S&E 4B	S2	S&E 1B	S3	S&E 2B
43	S8	Post 2B	S5	Post 3B	S6	Post 4B	S7	Post 1B
44	S8	S&E 4B	S5	S&E 1B	S6	S&E 2B	S7	S&E 3B
45	S2	S&E 3B	S3	S&E 4B	S4	S&E 1B	S1	S&E 2B
46	S2	Post 1B	S3	Post 2B	S4	Post 3B	S1	Post 4B
47	S6	S&E 4B	S7	S&E 1B	S8	S&E 2B	S5	S&E 3B
48	S6	Post 2B	S7	Post 3B	S8	Post 4B	S5	Post 1B
49	S1	Srch/Out 2A	S2	Srch/Out 3A	S3	Srch/Out 4A	S4	Srch/Out 1A
50	S5	Srch/Out 1A	S6	Srch/Out 2A	S7	Srch/Out 3A	S8	Srch/Out 4A

Thursday, July 16th

	VIC							
Session	**Alpha**		**Delta**		**Echo**		**Golf**	
	McKenna Live Exercises							
LUNCH								
51	S1	Loco-A	S2	Loco-B	S3	Loco-A	S4	Loco-B
52	S1	Srch/Out 1B	S2	Srch/Out 2B	S3	Srch/Out 3B	S4	Srch/Out 4B
53	S5	Loco-B	S6	Loco-A	S7	Loco-B	S8	Loco-A
54	S5	Srch/Out 4B	S6	Srch/Out 1B	S7	Srch/Out 2B	S8	Srch/Out 3B
55	S2	Srch/Out 4A	S3	Srch/Out 1A	S4	Srch/Out 2A	S1	Srch/Out 3A
56	S2	Srch/Out 3B	S3	Srch/Out 4B	S4	Srch/Out 1B	S1	Srch/Out 2B
57	S6	Srch/Out 3A	S7	Srch/Out 4A	S8	Srch/Out 1A	S5	Srch/Out 2A
58	S6	Srch/Out 2B	S7	Srch/Out 3B	S8	Srch/Out 4B	S5	Srch/Out 1B
59	S3	Srch/Out 2A	S4	Srch/Out 3A	S1	Srch/Out 4A	S2	Srch/Out 1A
60	S3	Srch/Out 1B	S4	Srch/Out 2B	S1	Srch/Out 3B	S2	Srch/Out 4B

Friday, July 17th

	VIC							
Session	**Alpha**		**Delta**		**Echo**		**Golf**	
61	S7	Srch/Out 1A	S8	Srch/Out 2A	S5	Srch/Out 3A	S6	Srch/Out 4A
62	S7	Srch/Out 4B	S8	Srch/Out 1B	S5	Srch/Out 2B	S6	Srch/Out 3B
63	S4	Srch/Out 4A	S1	Srch/Out 1A	S2	Srch/Out 2A	S3	Srch/Out 3A
64	S4	Srch/Out 3B	S1	Srch/Out 4B	S2	Srch/Out 1B	S3	Srch/Out 2B
65	S8	Srch/Out 3A	S5	Srch/Out 4A	S6	Srch/Out 1A	S7	Srch/Out 2A
66	S8	Srch/Out 2B	S5	Srch/Out 3B	S6	Srch/Out 4B	S7	Srch/Out 1B
67	S7	Srch/In 3	S8	Srch/In 4	S5	Srch/In 1	S6	Srch/In 2
68	S3	Srch/In 4	S4	Srch/In 1	S1	Srch/In 2	S2	Srch/In 3
69	S8	Srch/In 1	S5	Srch/In 2	S6	Srch/In 3	S7	Srch/In 4
70	S4	Srch/In 2	S1	Srch/In 3	S2	Srch/In 4	S3	Srch/In 1
71	S5	Srch/In 3	S6	Srch/In 4	S7	Srch/In 1	S8	Srch/In 2
72	S1	Srch/In 4	S2	Srch/In 1	S3	Srch/In 2	S4	Srch/In 3
73	S6	Srch/In 1	S7	Srch/In 2	S8	Srch/In 3	S5	Srch/In 4
74	S2	Srch/In 2	S3	Srch/In 3	S4	Srch/In 4	S1	Srch/In 1
	Make-up; Debrief							

APPENDIX C: USEX Questionnaire Forms

VIC CAPABILITY ASSESSMENT QUESTIONNAIRE

USER EXERCISES

ID:________________
Day: _____ Time:____

Please answer these questions about VIC ___. Check the box that most closely corresponds to your experiences in the VIC.

	How *similar* was the way you performed each task in the VIC compared to the way you perform it in the real world?					**How *quickly* could you perform each task in the VIC compared to how quickly you can perform it in the real world?**					**How *well* could you perform each task in the VIC compared to how well you can perform it in the real world?**					**How *difficult* was it for you to perform each task in the VIC compared to how difficult it is in the real world?**				
	Exactly Like	**Very Similar**	**Somewhat Similar**	**Very Different**	**Completely Different**	**Much Quicker**	**Somewhat Quicker**	**About the Same**	**Somewhat Slower**	**Much Slower**	**Much Better**	**Somewhat Better**	**About the Same**	**Somewhat Worse**	**Much Worse**	**Much Less Difficult**	**Somewhat Less Difficult**	**About the Same**	**Somewhat More Difficult**	**Much More Difficult**
7 TACTICAL MOVEMENT																				
Outside buildings																				
Maintain formation																				
Move close to/hug building																				
Move past windows																				
Cross open areas																				
Breach door using SAW																				
Inside buildings																				
Enter building through mousehole																				
Enter building through doorway																				
Move around a corner																				
Move/climb up the stairs																				
Move/climb down the stairs																				
Exit from a building																				

VIC CAPABILITY ASSESSMENT QUESTIONNAIRE

USER EXERCISES

ID:________________
Day: _____ Time:____

Please answer these questions about VIC ___. Check the box that most closely corresponds to your experiences in the VIC.

	How ***similar*** was the way you performed each task in the VIC compared to the way you perform it in the real world?					How ***quickly*** could you perform each task in the VIC compared to how quickly you can perform it in the real world?					How ***well*** could you perform each task in the VIC compared to how well you can perform it in the real world?					How ***difficult*** was it for you to perform each task in the VIC compared to how difficult it is in the real world?				
	Exactly Like	**Very Similar**	**Somewhat Similar**	**Very Different**	**Completely Different**	**Much Quicker**	**Somewhat Quicker**	**About the Same**	**Somewhat Slower**	**Much Slower**	**Much Better**	**Somewhat Better**	**About the Same**	**Somewhat Worse**	**Much Worse**	**Much Less Difficult**	**Somewhat Less Difficult**	**About the Same**	**Somewhat More Difficult**	**Much More Difficult**
0 PERFORM ROOM CLEARING																				
Clear a hallway																				
Stack																				
Enter a room																				
Secure entry point																				
Take position within a room																				
Move past other personnel in room																				
Clear a room																				
Determine room is cleared																				
Establish security																				

VIC CAPABILITY ASSESSMENT QUESTIONNAIRE

USER EXERCISES

ID:________________
Day: _____ Time:____

Please answer these questions about VIC ___. Check the box that most closely corresponds to your experiences in the VIC.

	How *similar* was the way you performed each task in the VIC compared to the way you perform it in the real world?					How *quickly* could you perform each task in the VIC compared to how quickly you can perform it in the real world?					How *well* could you perform each task in the VIC compared to how well you can perform it in the real world?					How *difficult* was it for you to perform each task in the VIC compared to how difficult it is in the real world?				
	Exactly Like	Very Similar	Somewhat Similar	Very Different	Completely Different	Much Quicker	Somewhat Quicker	About the Same	Somewhat Slower	Much Slower	Much Better	Somewhat Better	About the Same	Somewhat Worse	Much Worse	Much Less Difficult	Somewhat Less Difficult	About the Same	Somewhat More Difficult	Much More Difficult
1 REACT TO CONTACT/ ENGAGE																				
Determine origin of enemy fire																				
Acquire target at higher elevation																				
Acquire target at lower elevation																				
Fire at enemy personnel																				
Switch firing hands																				
Fire in short bursts																				
Reload weapon																				

VIC CAPABILITY ASSESSMENT QUESTIONNAIRE USER EXERCISES ID:________________ Day: _____ Time:____ Please answer these questions about VIC ___. Check the box that most closely corresponds to your experiences in the VIC.	**How *similar* was the way you performed each task in the VIC compared to the way you perform it in the real world?**					**How *quickly* could you perform each task in the VIC compared to how quickly you can perform it in the real world?**					**How *well* could you perform each task in the VIC compared to how well you can perform it in the real world?**					**How *difficult* was it for you to perform each task in the VIC compared to how difficult it is in the real world?**				
	Exactly Like	**Very Similar**	**Somewhat Similar**	**Very Different**	**Completely Different**	**Much Quicker**	**Somewhat Quicker**	**About the Same**	**Somewhat Slower**	**Much Slower**	**Much Better**	**Somewhat Better**	**About the Same**	**Somewhat Worse**	**Much Worse**	**Much Less Difficult**	**Somewhat Less Difficult**	**About the Same**	**Somewhat More Difficult**	**Much More Difficult**
0 COMMUNICATE																				
Employ virtual radio																				
Identify own fire team members																				
Know location of team members																				
Communicate with *own* fire team																				
Communicate with *other* fire team																				
Report to higher –(to squad leader)																				
Indicate exit from room																				
Indicate room is clear																				
Consolidate & reorganize																				

STRUCTURED INTERVIEW
VIC

Name(s):	Date:	Interviewer:

1. What were the best features of each VIC?

VIC Alpha:	VIC Delta:	VIC Echo:	VIC Golf:

2. What were the least desirable features for each VIC? What features would you change?

VIC Alpha:	VIC Delta:	VIC Echo:	VIC Golf:

3. a) In which VIC was the visual display most like the real world?

   b) In which VIC was the visual display least like the real world?

1. a) In which VIC was movement most like the real world?

   b) In which VIC was movement least like the real world?

2. a) In which VIC was shooting most like the real world?

   b) In which VIC was shooting least like the real world?

3. How difficult was it to differentiate your fire team from the OPFOR?

4. What changes need to be made in the MOUT database? How does it need to be different?

5. Which pieces from the different VICs would you put together to form a new and better VIC?

6. What could you do tactically at the McKenna MOUT site that you couldn't do in the VIC?

7. What would the ideal VIC have to be able to do to have it be good for MOUT training?

8. What do you see new, improved VICs being used for?

9. What else did I forget to ask you? What else would you like to say?

APPENDIX D: Acronyms

- A -

AAR	After Action Review
ACR	Advanced Concepts & Requirements
ACTD	Advanced Concepts Technology Demonstration
ADST II	Advanced Distributed Simulation Technology II
AMC	Army Materiel Command
AMSAA	US Army Materiel Systems Analysis Activity
ANOVA	Analysis of Variance
APG	Aberdeen Proving Ground
ARI	Army Research Institute
ARL	Army Research Lab
AUSA	Association of the United States Army

- B -

BDI	Boston Dynamics, Inc.
BDU	Battle Dress Uniform
BFV	Bradley Fighting Vehicle

- C -

C4I	Command, Control, Communications, Computers, and Intelligence
CATT	Combined Arms Tactical Trainer
CCTT	Close Combat Tactical Trainer
CDRL	Contract Data Requirements List
CGF	Computer Generated Forces
CGFTB	Computer Generated Forces Terrain Database
CIS	Combat Instruction Set
CIS	Commonwealth of Independent States
CRT	Cathode Ray Tube
CTDB	Compact Terrain Database

- D -

DBBL	Dismounted Battlespace Battle Lab
DEM	Digital Elevation Model
DI	Dismounted Infantry
DI SAF	Dismounted Infantry Semi-Automated Forces
DIM	Dismounted Infantry Module
DIS	Distributed Interactive Simulation
DO	Delivery Order
DOT	Department of Transportation
DSS	Dismounted Soldier Simulation
DT	Dynamic Terrain

DWN	Dismounted Warrior Network
DWN ERT	Dismounted Warrior Network Enhancements for Restricted Terrain

- F -

FEA	Front End Analysis
FOR	Field of Regard
FOV	Field of View
FT	Fireteam
FTL	Fireteam Leader

- G -

GPS	Global Positioning System
GOCO	Government Owned Contractor Operated

- H -

HMD	Head Mounted Display

- I -

IC	Individual Combatant
IC SAF	Individual Combatant Semi-Automated Forces
IDA	Institute for Defense Analysis
IFOV	Instantaneous Field of View
IG	Image Generator
IHAS	Integrated Helmet Assembly Subsystem
I^2	Image Intensification
IR	InfraRed
IUSS	Integrated Unit Simulation System

- L -

LAN	Local Area Network
LCD	Liquid Crystal Diode
LM	Lockheed Martin
LMIS	Lockheed Martin Information Systems
LMSG	Lockheed Martin Services Group
LMTSG	Lockheed Martin Technical Services Group
LOD	Level of Detail
LOS	Line of Sight
LW	Land Warrior
LWTB	Land Warrior TestBed

- M -

M&S	Modeling & Simulation
MES	Multiple Elevation Surfaces
MOBA	Military Operations in Built-up Areas
ModSAF	Modular Semi-Automated Forces
MOP	Measure of Performance
MOS	Military Occupational Specialty
MOUT	Military Operations in Urban Terrain

- N -

NAWCTSD	Naval Air Warfare Center - Training Systems Division
NBC	Nuclear, Biological, Chemical
NET	New Equipment Training
NPS	Naval Postgraduate School
NVESD	Night Vision Electro-Optical Systems Division
NVG	Night Vision Goggles

- O -

ODT	Omni--Directional Treadmill
OICW	Objective Individual Combat Weapon
OPFOR	Opposing Forces
OSF	Operational Support Facility
OTVIS	Operational Test Visualization

- P -

PC	Personal Computer
PDU	Protocol Data Unit
PL	Platoon Leader
PM	Program/Project Manager
PS	Platoon Sargent
PVD	Plan-View Display

- R -

RBD	Reality by Design
RD&E	Research, Development & Engineering
RDA	Research, Development & Acquisition

- S -

SAF	Semi-Automated Forces

SAIC	Science Applications International Corp.
SAW	Squad Automatic Weapon
SGI	Silicon Graphics, Inc.
SL	Squad Leader
SME	Subject Matter Expert
SOAR(A)	Special Operations Aviation Regiment (Airborne)
SOW	Statement of Work
SSCP	Sum of Squares and Cross Product
STOW-A	Synthetic Theater of War - Army
STRICOM	Simulation, Training & Instrumentation Command
SUTT	Small Unit Tactical Trainer
SVGA	Super Video Graphics Array
SVS	Soldier Visualization Station

- T -

TCP/IP	Transmission Control Protocol/Internet Protocol
TECOM	Test and Evaluation Command
TIN	Triangulated Irregular Network
TIM	Technical Interchange Meeting
TRAC WSMR	TRADOC Analysis Center - White Sands Missile Range
TRAC MTRY	TRADOC Analysis Center - Monterey
TSM	TRADOC System Manager
TTES	Team Tactical Engagement Simulator

- U -

UDP/IP	User Datagram Protocol/Internet Protocol
USAIC	US Army Infantry Center
USEX	User Exercises
USMC	US Marine Corps

- V -

VGA	Video Graphics Array
VIC	Virtual Individual Combatant
VMF	Variable Message Format

- W -

WISE	Walk-In Synthetic Environment

- X -

XGA	Extended Graphics Array